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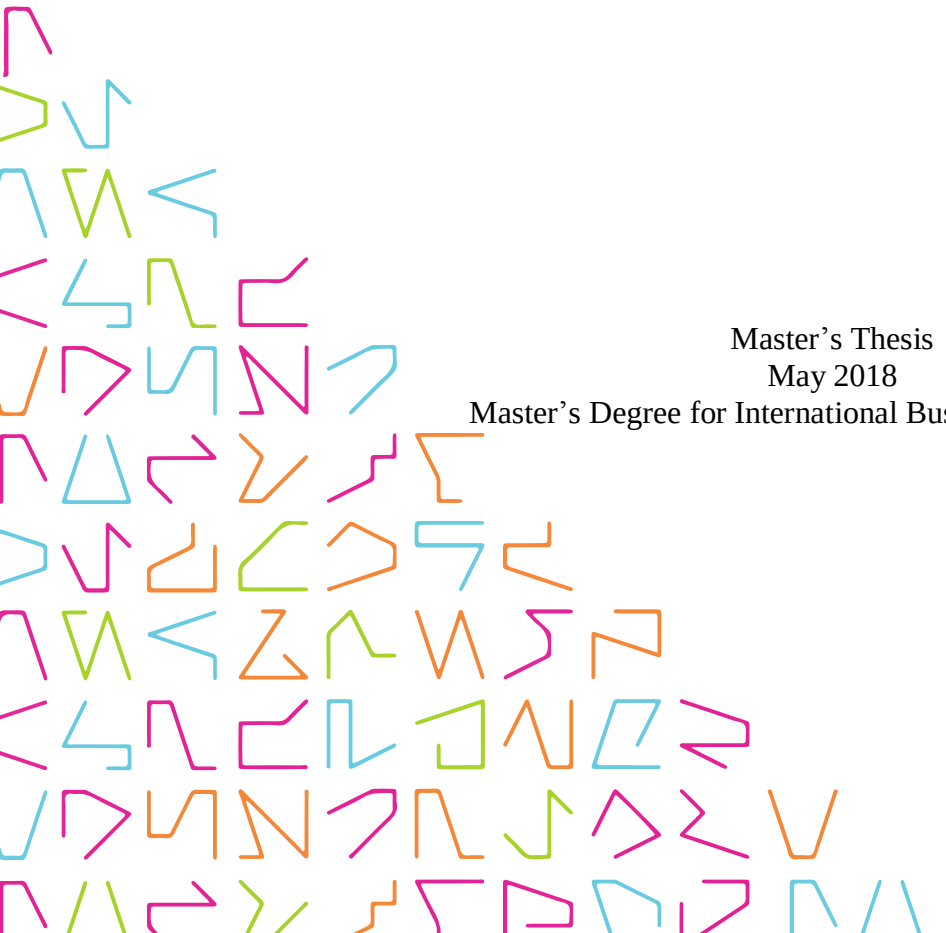
DEFINING OPTIMAL WAREHOUSE LOCATIONS FOR EUROPE AND NORDICS

Case: Metso Minerals Inc.

Katja Luoto



Master's Thesis
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ABSTRACT

Tampere University of Applied Sciences
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Defining optimal warehouse locations for Europe and Nordics
Case Metso Minerals Inc.

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The purpose of this thesis is to focus on distribution supply lanes for wear parts to customers in Europe and Nordic for company Metso Minerals Inc. The aim is not to implement, but to carry out a study which would result suggestions on where the warehouses should locate and how many should there be so that customers could be served with promised service level.

The study was carried out with cooperation with an external party. The data for the study is gathered from ERP and reporting systems used by Metso Minerals, whereas the tools used for supply chain modelling were provided by the external party.

The outcome of the study was not only suggestions for improvements, but also a statement how current distribution set up looks for person looking from outside and therefore also a baseline for improvements. The suggestions given include simplification of the distribution supply chain though localization and a reduction in terms of number of warehouses in the regions in scope.

Key words: supply chain, distribution lane, warehouse, transportation, lead time

TABLE OF CONTENTS

TERMS AND ABBREVIATIONS

SCM	Supply Chain Management
KPI	Key Performance Indicator
CRM	Customer Relationship Management
SKU	Stock Keeping Unit
FTE	Full time equivalent. Number of full time employees needed to carry out defined task
PGI	Post Goods Issue
FTL	Full Truck Load
ERP	Enterprise Resource Planning systems
DC	Distribution Center
FCL	Full Container Load
LSP	Logistics Service Provider
COG	Center of Gravity
D&L	Distribution and Logistics organization within Metso Minerals Services

1. INTRODUCTION

How should the warehouses be located so that they would enable customers to be served with the promised lead times? What is an optimal warehouse set up for a distribution supply lane when the wear parts in questions are heavy, bulky and therefore slow and expensive in terms of transportation. Case company Metso Minerals Inc. started a project to improve customer leadtimes through localized inventory and simplification of supply lanes in Europe and Nordics. The topic for this thesis is a side track of the project in questions, as it was not known if currently existing locations would support well enough the target of being customer centric and if current locations would be most profitable ones in terms of freight costs.

In the past Metso has aimed to reach all customers over Europe and Nordics in [redacted] days service level agreement (SLA) from order received to delivery, with a centrallized warehouse and distribution lane structure with standard transportation. The same target time has been in place for all materials regardless of nature of the goods, spare or wear parts. Due to the target being unreachable, as part of the customer lead time improvement project for wear parts, SLA is being re-evaluated to define possible new service levels. Currently existing SLA sets target times for the lead time followed within the study done for this thesis.

The conducted study is done in cooperation with external service provider looking to find answers to questions ‘what would be the optimal warehouse locations in Europe and Nordics’ and ‘how many warehouses should their be’. Even though the target is improve customer service through improving service levels with faster lead transportation lead times from warehouse fullfilling the SLA. The optimal solutions means that the target is to find breakpoint between costs and lead times. The purpose of the study is not to implement or to create a plan for implementation, but to provide recommendations and also grounds for decision making.

This version of the thesis as been modified hide all figures and results from the study that was carried out. Also appendixes presenting figures gathred during the study have been left out, even tough the text refers to them. Outher vice the content between published and originalversion are the same.

2. EFFECTS OF SUPPLY CHAIN MANAGEMENT

Thinking back on how businesses were run 15 year ago and comparing to today's environment the biggest change has not been in the products purchased. The range of items and the way products are brought available have changed from local convenience stores to hypermarkets and local clothing stores to Zalandos and alikes. Business' are differentiating from each other by service they provide. Focusing on price is no longer main importance. The service is about the extra the company can create and it's what sets them aside from competitors. The service is produced through supply chain strategies, at the same time ensuring profitability. For some strategy centralizing their warehouses to ensure smaller inventories, but at the same time taking more time to get the goods delivered to customers, others decide on the opposite. The next chapters focus on understanding what is Supply Chain Management (SCM), what kind of effects it has on business environment and how it can be used to differentiate from competitors.

2.1 Supply Chain vs. Logistics Management

Supply Chain Management as a concept is regularly intepreted to stand for same as Logistics Management. Where as Martin Christopher (2016, 2) defines the concept of Logictics as the strategic management of material and information flows through out the organization; purchasing, moving, storage of materials, part or finished inventory. The flows are to be managed in a manner that profitability is maximised and the orders are full filled cost- effectively. Ultimately target of Logistics Management is to get the right parts to right place, right time in most cost effective way.

Supply Chain Management continues to build up from the framework built by the Logitics Management and broadens the focus to managing the upstreams and downstreams with customers and suppliers in order to deliver customer value with a less cost as supply chain as whole (Chistopher (2016, 3). John T. Mentzer and his co-authors (2001) simplified SMC in their paper even further by stating supply chain management to be a set of three of more companies that are involved in up- and downstream flows of tangible or intangible factors from source to customer. For this paper we conclude Supply Chain Management to look to create value to customer, by optimizing the cooperation and relationsships with parties involved in profitable manner.

Given to the topic of the thesis we will focus on the concept of Supply Chain Management as that provides the strategic framework to the case. However as the theories that support the set targets for the study like customer centricity and changes in distributions channel are more about Logistics Management, own chapters are dedicated for the topic. The next chapter will focus on SCM more throughly as the concept and Logistics Management will be covered in chapter 2.3.

2.2 Supply Chain Management

Supply Chain Management as a concept is rather new, the first written words were published in 1982 by Keith Oliver and Michael Webber, who declared that looking for trade off within organizations internal key functions, like sales, purchasing and distribution, no longer worked too well and things needed to be looked from a new perspective; the Supply Chain Management (Christopher 2017, 3). The core though behind the approach is no company is an island and how SMC is not only about physical movement of goods but also information flowing back and forth, as pictured in figure 1.

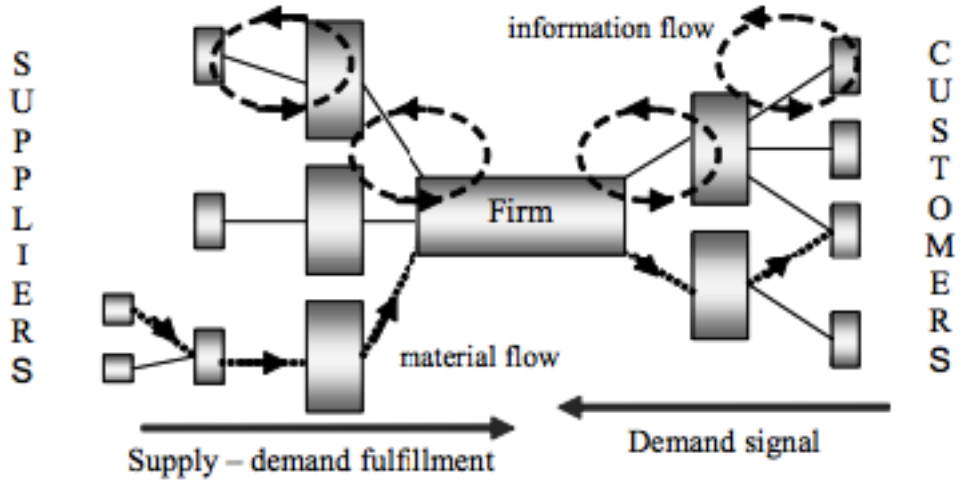

Figure 1. Supply Chain Adopted from Iskanius, 2006

There are almost as many interpretations for Supply Chain Management as there are papers written over the topic. They all do share the common theme: operations are to be managed across the organization boarders (New, Westbrook, 2004, 2) and that SMC lays down the guidelines per which strategies for inventory management, logistics

management and all other internal functions are created. The generally accepted norm is laid down by the Global Supply Chain Forum (1986) run by Douglas M. Lambert

"Supply Chain Management (SCM) is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders"

Figure 1 gives an overall over idea of SMC, but taking a closer over the topic, it can be seen, that SMC goes deep into company's key functions, just like Webber and Oliver interpreted. Supply Chain Management considers different functions within an organization all with a perspective of their own: purchasing, logistics, marketing, production, research and development and finance. Roughly said SMC lays down the guidelines for all actions and tying them together.

Within each perspective the companies have their internal processes and as Lambert (1986) concludes SMC narrows down the silos between the functions internally, but also aims to cut down the boundaries between companies. Ones manufacturing flow management requires always another company's order fulfillment, which means one's target sets also the target for other. Or to bring out the topics mentioned on prologue, one company can create the value for next by being able to fulfill the targets they set, eventually turning out as part of others supply chain. The value creation is discussed more in detail in later chapters.

Supply Chains come in different form, as Mentzer (2011) states they can be simple direct supply chain with three parties or extended Supply Chains where also supplier's supplier and customer's customer are joining. Nova days most frequent form of Supply Chains tends to be an ultimate Supply Chain where 3rd and even 4th party providers are brought in to control matters like logistics or finance. Naturally each company can be part of numerous individual chains.

2.2.1 Measuring the Supply Chain

Metrics can be seen from several point of views; managing and reporting and investing and developing. Each company has their own set of metrics, others are more detailed, some tie in actions of multiple functions. For Supply Chain the most valuable metrics are cross functional, as that is what Supply Chains are; functions and companies working together towards a common goal. Within this chapter will focus more on metrics, the key performance indicators, and what are the best of kinds.

To be able to measure Supply Chain the silos between the functions need to be narrow and the information flow consistent. Best of metrics are then cross functional, also called compound metrics. Compound metrics are combinations of two or more individual metrics resulting a metric that support Supply Chain Management better than individual metrics (Cesere, 2017). Examples of compound metrics are on time delivery; was there material available to be shipped at promised time, did warehouse process the order on time, was transportation on time or cash to cash; how many days there are between receiving the payment and days in the inventory compared to days having to make the payment over the same material.

Other similar metric that considers multiple functions are referred by Christopher (2016, 266), Cecere (2014, 24) and Poirier (2008, 187) with an idea of a perfect order. A perfect order is something that is desired and again measures performance over functions silos. Perfect order can be interpreted in two different ways depending who is asked. First is a share of orders shipped as promised out of all orders and second is an order that fulfills or even outdoes the set expectations. As an example, company's sets a promised that the goods are delivered within a fixed number of days from order entry. The promised time is calculated following an approach, if everything goes as it should according standard process.

Metrics in general are something measurable, mostly in numerical form. Metrics in supply chain are never just internal; the and relations ships towards customers and suppliers managed in a way that set targets could be reached. The metrics should be set to support the strategy set by the company's management. Best of companies are systematically tracking the set metrics that support them to raise above their competitors

and build stronger customer satisfaction (Poirier, 2008, 187). In the next chapter, there will be more about tradeoffs that might be needed to be taken to support the strategy and to reach competitive advantage.

For better success companies are building their business models from the end towards the middle, following the model in Figure 1. This means that understanding the value of customer centricity; making customer happy is the primary target when forming your strategy or networks, or in other end managing supplier relationships, meaning thinking yourself as the customer. Designing the strategies will be discussed more in detail in chapter 2.3 After having this done and figuring out what are key points to highlight, companies can align their processes so that they enable measuring metrics that matters (Cecere, 2014, 46-47). These key points are the ones to support company's strategy and the points which later will define how company places itself in the market. Like Zalando, they op to carry out large range of materials online over being a chain of local shop, where materials can be delivered with quick schedule. By building their measures this way, companies can measure functions that are valuable and enable to courage towards development.

2.2.2 Key Performance Indicators

Even though talking about metrics the term key performance indicators (KPI's) is mentioned for the first time now. KPI is a metric, as any other measure that was referred to in previous chapter, but all metrics are not part of KPI. Key Performance indicators differ for other metrics by its strategic value as driver, they each focus on activities that bring the most value to company. Therefore, KPI's enable to set focus on the most important, but also serve as a vehicle for communication (Eckerson, 2007). For organization leaders 5 -7 KPI metrics is manageable and supportive to strategy (Cesere, 2014,8).

Each company and each organization have their general KPI's based on which their success is reported and often also awarded. Like with any measure KPI's are not to be something that exist for the joy of existing, but to be analyzed and managed. Cesere (2014, 8) quoted one of her interviewees in her book by stating that best of metrics are actionable. This defines the number of metrics, but also that they are understood. By

understanding how the KPI is built, finding root causes behind increased numbers can be found and that way problems can be faced and corrected.

For Supply Chain Management, good measures are cross functional, like availability or on time delivery, as those reflect to main idea of supply chain – connecting functions to work together towards common target. When KPI's are not only well communicated, but also combining one metric to measure multiple functions it can be ensured that work is done towards common target (Eckerson, 2007). By building cross functional KPI's the number of metrics can be cut down to make metrics more manageable for leaders.

2.3. Supply Chain Management & Marketing

Last two chapters refferred to idea of identifying metrics that do support the business strategy, therefore this chapter is all about the strategy. Marketing and Supply Chain Management are not traditionally linked to each others, they have been more of two distinct functions. Thinking years back, the succesfull companies have the ones who are able to provide the lowest price. Lowest price has been greated through economies of scale, gained through sales volumes. Today more emphasis is on customer and the values generated for them together with the cost perspective. Those two together can be reached with effective supply chain management, which can can therefore be stated to be one of the most powerful tools for achieving the competetive advantage (New, Westbrook, 2004, 24). As Handfield and Nichols (1999, 1) state Supply Chain strategies should be created by drive from other chains within organization, like marketing, which then would support goals of the organization and implemented to minimize costs and maximise profits and abilities to offer the service level promoted by marketing.

Marketing is driven by relationships and supply chain by networks, both eventually meaning the same thing. Customer Relationship Management (CMR) as well as Supplier Relationship management both share common goal, but looked from one from an angle of buyer, other from an angle of customer: to deliver value at less as a supply chain as whole (Poirier, 2008, 25). Lassard and Zinn (1995) brought up that succesfull relationships and find effective cost levels by integration of policies through combatible cultures and management strategies. Mentzer (2011) also lists long term relationships between supply chain partners as key characteristic for succesfull SCM.

Marketing has traditionally traditionally been based on four P's: product, promotion, price and place. Today the perspective towars marketing has changed towards creation of value towards customer and consumer being as key to success (New, Westbrook, 2004, 23) .Value towards customer can be defined as the difference between gained or percieved benefits and total cost of ownership (Christopher, 2016, 29). Harvey Golub and Jane Henry (2000) in their article in that the value can be considered as the maximum price the customer is willing to pay for the product. Anderson and Narus (1998) state in their article in Harward Business Review in business markets value stands for worth of technical, economic, service or social benefits the customer receives in monetary terms against the price they invest. Following these statements it can be said that value is not only the actual benefit of the product, but also how the whole order process is carried out and how that fits into the customer's supply chain. Hence it can be said that it is not wonder supply chain is also considered to be called 'value chain', as that what the main outcome of a supply chain is.

The place in the 4 P's for marketing stands novadays for market placement. How is an organizations set themselves apart from competitors. Product along with prices influenced by economies of scale no longer alone effecting on market placement. Marketing strategy is crafted along with the service customers require from the company. When the product alone will not differentiate one company from an other, therefore customer service and the value becomes the key factors. For differention company needs to acknowledge it's competetive advange.

Value can not be created similarily to all customers, nor everyone sees your way of differentiating as an advantage; some may require fast deliveries, some require more technical support, others highlight the importance of availability or customer service – nor can one company tick all the boxes every customer wishes. Should companies identify which customers are more important than others for supply chain purposes? The next chapter is focusing on customer segmentation and it's affects on value created towards the customers.

2.3.1 Customer value vs customer profitability

To create value to customer it must be first understood the idea of no company is an island. Each supply chain is linked to one of an other company and the strongest performers are the ones who are integratable. Poirier stated (2008, 190-192) dicussing the role of supply chain management effects over customer satisfaction that focus on customer satisfaction is the main driver for supply chain initiatives, that will eventually affect on internally costs and profits, but of course to value generated. Anderson and Narus (1998) wrote that knowing the essence of created customet value gives company means to get equitable returns to their values. As stated earlier Supply Chain Management is to genereate the value to customer's in most optimal way possible, which means that solutions done within the supply chain are to focus on generating the value without it creating a stop to the flow within the supply chain.

Second factors brings along topic of Customer Relatioship Management discussed in chapter 2.3. All customers do not create the company equal profit, nor the company posses similar relation ships with all suppliers. To summarize Christopher's (2016, 44) statement different customers buy different quantities, but also the cost of serving one customer can be notably higher than the others. One small customer may require exeptions to each order they place or keeps making large orders with constantly changing specifications, where as a large one accepts signs a life cycle contract and lets the company handle the supply chain actions independently.

Understanding the customer's profitability supports the decision over what type of relationship company should proceed bulding with the customer; which should a relationship be built with, with whom to agree to make exceptions and which ones to tie in to the standard. Pareto's law can be used to explain how 80% of all sales are made to 20% of all customers. This information can be applied when working towards customer segmentation or simply as a tool to support on building and executing supply chain or marketing strategy.

2.3.2 Competitive Advantage

Supply Chain Management together with logistics are a major source of competitive advantage. In short, company can set itself into a superior position compared to its competitors in terms of customer preferences by managing its supply chain and logistics together Key to competitive advantages are differentiating yourself in customers' eyes

positively and being able to generate greater profit though lower operating costs (Christopher, 2016, 4). These factors lead to placing yourself in the market, which was referred to in the previous chapter.

According to a study made by Li, Ragu-Nathan, Ragu-Nathan and Rao (2004) price, quality, delivery and flexibility were identified as the most important components for competitive advantage. Below presented figure 2, shows these factors effected by Supply Chain Management effect on strategic advantage created. The figure 2 presents how value and productivity are placed as x and y. The more value is generated for customer the higher you are in value advantage side opting to become the service leader. Being strong on value side company's strength is in flexibility, reliability or ability to react on changes. On productivity side the strength is then in ability to provide the product itself at lowest cost. Strongest position in the market is for the companies who manage their operations and supply chains so that they possess the placement as cost and service leader. The cost and value advantages will be discussed in further chapter together with supply chain and logistics perspective.

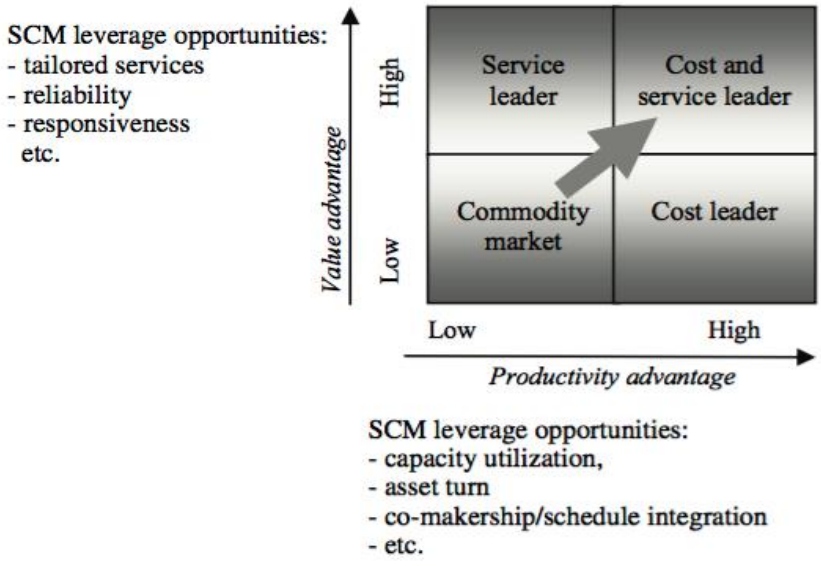

Figure 2. Strategic advantage positioning of companies. Adopted from Christopher (1998)

As written earlier, the cost advantage has traditionally been gained through high volumes, that of course is still valid. However supply chain management and more efficient managing of logistics can contribute greatly to unit costs. Therefore the value perspective comes out more interesting to look at. Unless your product is branded on

Apple level or differentiated far from others, to be able to gain value advantage, customer relationship management comes along.

Value a customer precieves differs per product and business. For some value is fast deliveries, for some being able to modify the product or service to suit the exact need and for some being able to functions without inventory carrying costs. As stated in previous chapter, the gratest initiatives for supply chain management come from customers through CRM. Company strategy is then drafted based on the market placement and advantage that is wanted to be percieved. The execution is then left for Supply Chain and Logistics Management.

2.4 Logistics Management

Within the following chapter focuses more in details in ideas behind Logistics Management. Logistics Management contains the processes of over transportation, inventories and warehousing activities, meaning material flows from supplier until customer, not forgetting the strategies related to each process and throughout the organization (Christopher 2017, 2). Logistics Management supports the research questions set for this thesis, but as it SCM creates more base for strategic decision the theory part was started with it.

2.4.1 Logistics Management strategy

It can be said that logistics management is responsible over the two of the largest spends that companies have: sourcing and inventory, and logistics meaning warehouse and transportation. Depending on the type of business the logistics costs may generate portion as high as 5 -15 % of company's revenues. The operations that are included under logistics management are the ones that manage the flows of the materials, not forgetting the information flow, throughout the supply chain in operational and strategical level; internal, inbound and outbound (Poier, 2008, 145). Harrison and van Hoek (2008, 7) define Logistics management as a task of coordinating information and material flow throughout the supply chain.

As Logistics Management strategy dives deeper to Supply Chain strategy and specifies it into operations that are within reach of Logistics Management. If Logistics Strategy and operations within it are not following the priorities set by Supply Chain strategies, the end customer cannot be served on wanted level (Cousins, 2005, 403-428). The operations that are part the logistics processes are warehouse and inventory management, and transportation together with services provided alongside of each. The individual operations are discussed further in upcoming chapters. Harrison and van Hoek (2008, 27) highlight that successful logistics strategy requires systematic open communication and strategy settings between network partners, which sets requirement for relationships with counterparties: suppliers, customers, 3rd and 4th party service providers.

Important part of creating a logistics management is being able to identify, and also understand concept of tradeoffs. Strategy should know to not only set priority, but also understand what cannot be done; responsive supply chain is not an effective supply chain (Harrison, van Hoek, 2008, 29). Figure 3 visualizes as an example how number of facilities effect on different logistics operations within the company in comparison to total costs. Harrison and van Hoek continue to state that is addition to cost, time is other major influencer in defining logistics strategy and also the main factors of tradeoffs to be made; fast is not cheap. These strategic decisions set the tone for service or the experience is mainly generated by the logistics execution.

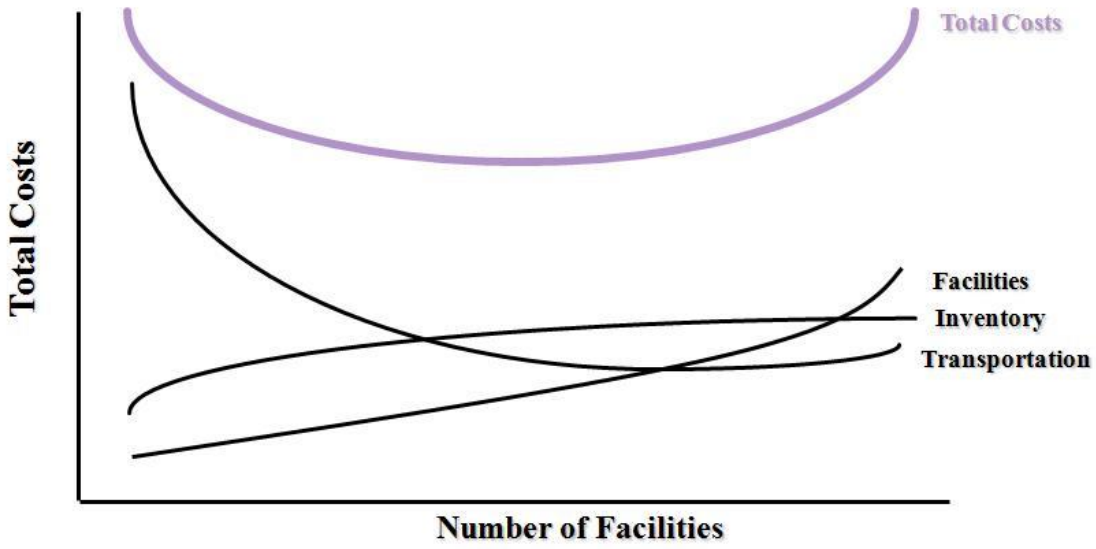

Figure 3. Cost of distributions network. Adopted from Gionata's blog (2010)

2.3.2. Warehouse and inventories

Warehousing will here on be reviewed from inventory point of view, as well as warehouses are part of distribution channels, leaving out the actions carried out in one. From logistics management perspective warehouse is also often a heart of value adding services, consolidation and packing functions, not forgetting how warehouse processes from receiving, storage and outbound are notable part of lead time the customer experiences. However, to be able to focus on more valid part of the thesis, the focus will now be more on inventory values and strategies, as well as availability and inventory locations.

If logistics is alone the second largest spend for companies, sourcing and therefore inventories are the largest, according to Christopher (2016, 86-87) the inventory holding costs sum up to 25% of the distribution cots. Generally companies opt for aiming to keep inventory levels down by different inventory strategies or by centralizing warehousing when among with operating costs. There are numerous inventory strategies, most known are probably pull and push strategies, just-in-time (JIT). Pull strategy makes the purchasing actions per customer demand keeping inventory carrying cost down, whereas push strategy purchases first and then does it best to get materials sold to market. JIT focuses on minimize the time of having the material in stock, by purchasing just at right time for customer need.

The main operation affecting on inventory is purchasing with a tight link to customer demand. The purchasing strategy applied is aligned with the company's overall business plan (Harris, 1996), but also to strategies for partners. Manufacturers aiming to ship large batches with flexible dates conflicts with customers wanting to maintain low inventories, making company's purchasing strategy to fail (Handfield, Nichols, 1999, 4). Therefore the main trade off in inventory terms is whether company accepts higher level of inventory to be flexible and reliable in terms of customer service and value creation or accept the risks of not having availability when needed.

To match with the inventory levels with the strategic positioning company wants to receive as well as the supply chain strategy. Defining the optimal level is difficult as cost of having shortage in stock in comparison to carrying out higher inventory levels is difficult to calculate (Aardal, Jonsson and Jönsson, 1989, 65-66). To reach the service level wanted inventory management recognizing materials that critical or non-critical in demand Dekker, Kleijn, de Rooij, 1996. For inventory purposes, non- critical can be defined as non- stocking items or to be stocked only in limited facilities. The critical ones define then the range of materials to be carried on the inventory. The split between safety critical and not-critical does not alone ensure customer service levels, also safety stock levels for each material is defined to ensure availability of each. Safety stock is related to idea of a perfect order, which was referred to in chapter 2.2. having the stock always on hand when needed to deliver the customer within the promised schedule.

2.3.3 Transportation

As transportation is required each time material is moved from one locations, transportation is the second largest individual spend related to supply chain and linked to activities throughout the logistics chain. Transportation is part of inbound and outbound, but also moving goods internally within location or from one location to other. Transportation is eventually responsible to fulfill the main target of logistics management; to get the goods to right place, right time. A good transportation system enable logistics to improve efficiency, reduce operational costs and promote service quality, in addition to bringing logistics management activities to their best (Tseng, Yue, Taylor, 2005)

The tradeoff used as an example in previous chapter provides also a good example for transportation point of view. Handfield and Nichols (1999, 4) state that ordering bigger slot sizes from supplier enables lower transportation costs, but might cause having to use more expensive, faster delivery options to customer to carry out promised service level to customer. Or the other way around smaller slots from supplier or higher inventory levels, enable to choose optimal transportation mode to deliver to customer. For satisfy the promised service level to customer, more expensive transportation option might be used if earlier steps in logistics chain fail.

The decision made by transportation manager is to define which mode of transportation to use to follow set strategy (Handfield, Nichols, 1999, 16). Differences between transportation modes are used to carry out different service levels. Choosing courier service over truck is naturally faster option, but also more expensive. Internationally difference is clearer between air freight and ocean freight. Shipper bigger batches, like bulk or full container loads, are also relatively more economical to ship than individual pallets. In addition to cost and speed of service, strategic decisions done for transportation relate to reliability, visibility and how frequency integrates to processes.

Transportation is often one of the operations that are considered being their core competence and therefore they cannot create value to customers in competitive way (Christopher, 2016, 198-199). Relationship management with transportation service provider through contracts supporting strategy and quality requirements enable enhance the performance and support growth (Wilén, 2015). At the same time contracts support optimization in terms of loading scheduling or visibility through interfaces between systems used.

2.3.4. Distribution channels

Poirier (2008, 147) refers in his book to an article "The Seven Principles of Supply Chain Management" by Anderson, Britt and Favre in Supply Chain Management Review to one of the seven principles – differentiating the product closer to customer and that way speeding the flow through the supply chain. Even though Poirier refers more to production specific approaches, I think it is perfectly valid also for distribution purposes. Distribution channel stands for physical location from which the materials are distributed to markets, traditionally they were considered as means to fulfill the physical demand of customer (Christopher, 2016, 97). Distribution channel can there can stand for physical locations, but also how a company decides to stock the material. One might prefer one location for whole market, where as others might want to take inventory, all or some, closer to markets. Through these decisions they company can effect on the value created for the customer.

Distribution channels are highly strategical decisions from logistics management point of view. As they reflect to number of locations and the inventory range carried, does it link closely to inventory values, but as speaking about proximity also to transportation costs

in outbound. The volumes for inbound and therefore the transportation costs also differ as number of locations changes. Christopher (2016, 2017) brings up example of distribution centers working with fast moving consumer goods to aim to serve whole Europe from two locations, one in north-west and other in southern Europe.

The inventory carrying side of the distribution channels can be about the material range carried or how Martin Christopher describes; defining from where customer is served depending on the content of his order. Christopher (2017, 82-83) brings up the topic of understanding distribution channels and how they could be reconfigured to match changing environment and multi-channel distribution. Multi-channel distribution stands for customer making its purchase throughout one order, but gets deliveries from multiple dispatch locations. The idea is usually referred as Omni channel. The examples related to these two terms are usually of Amazon or alikes where inventory is not under one owner. However limiting inventory closer to customers for limited inventory and centralizing rest of inventory functions through similar approach.

3 RESEARCH METHODS

As the research carried out for the thesis aimed to provide answers to set questions over within defined frames aiming to define current level and providing alternative solutions for comparison and improvement is normative research methods are used for the case study. Given that the research leans towards defining key factors and their effects towards each other the research framework is more theoretical than empirical. More detailed theories over the above mentioned are explained in next chapter 3.1.

The research for the study itself was carried out with a help of external consultant following steps: data collection, data validation, strategic framework, scenario definition and modelling and determining optimal solution. The data was collected to QlikView which enabled to visualize and therefore also validate the current situation. For the simulation of alternative scenarios tool called CAST Aurora was used. The study process, as well as tools used are described further on in upcoming chapters.

3.1. Theory

As the topic of the study eventually aims to create grounds for decision making through analyzing gathered data into constructed models and eventually through observations and data analytics empirical research is used. For supportive method, as the scope of the study is limited and external party is on purpose left without detailed knowledge and limitation characteristic to the business is research method towards the case study ran normative. As a research method, a case study is used.

Empiricism as research method looks to study the object through experience and observations. Empirical research is generally used for tangible objects, people or events in contrast to factual sciences like mathematics (Routio, 2007). For this study, the process the study followed focused on decision making methodology aiming to find a solution to a problem through constructing the problem into mathematical form and creating models to mimic current solutions to identifying the problems. Reconstructing models through chosen scenarios to see alternative solutions with empirical approach recommendations over improvements can be given (Aramo-Immonen).

The study takes a normative approach as aims to provide an answer on how things should be, in addition to gathering the facts (Routio, 2007). Normative research is divided into two styles of research; general normative research and normative case study. Normative case study differs from general research through including implementation of suggested improvements. As implementation was not part of the conducted study general normative research was used with a focus on providing recommendations through designing changes to distributions the supply lanes in scope.

As main aim for normative research is to improve the present state of while pointing a direction towards improvements. To define the direction for the developments the interest group or from whose point of view the should be assessed. Interest groups can be the company itself or functions or divisions within. Interest groups outside of the company itself can be for example the employees, customers, suppliers or even the shareholders (Routio, 2007). For this study the interest group is the company itself, as the target is to find the optimum solution, not the best for customers, even though the words customer centric is used.

3.2. The study

The study carried out for the thesis was done in co-operation with an external partner. The decision on using an external partner was rather clear, because regardless Metso having the required data available, it does not have the tools or knowledge to form the scenarios nor calculations wanted internally. Also to present cost factors needed for the comparison in results, network of an external player was needed. After comparing offers, corresponding studies and understanding of 4 partners in the field of Supply Chain Management it was decided to carry out the study with service provider that Metso already uses as warehouse partner in Europe, but also in other continents. The decision was done on the grounds of them already being familiar with the business provided; items, processes and understanding on what the study aimed for immediately.

The study was agreed to last over period of 12 active weeks, starting with a kick off meeting in the end of September targeting to present the results in mid-January 2018. The study consisted over 5 steps; data collection, baseline validation, strategic framework, scenario definition and modelling and determining optimal solution. Each step is opened more in detail in following chapters. On both sides the participants

consisted of project team and steering committee. On the service providers side the project team consisted over the project manager, supply chain consultant working with the data and consultant. On Metso's side the project team was smaller, only consisting of me acting as project manager with a close support from steering committee.

3.2.1. The expected outcome and scope

The expected outcome of the study was agreed to identify where the warehouse or warehouses in Europe and Nordic should be located to best serve the customers. Finally aiming to find out how the number of warehouses and location of each effects on transit times to customers and therefore the promise of service level that Metso can give. Target is not come up with an implementation plan for warehouse rotation, but grounds for future per which Metso can continue improving its footprint within the defined region to ensure customer service objectives are met.

As explained in previous chapter explaining the current situation the parts handled through distribution centers in Metso are divided into two main categories spares and wears. Within the scope for this study are only the wear parts, as due to their characteristics they are more expensive and slower to transit. This approach also supports projects carried out earlier within Metso which aimed to bring warehouses for wears closer to markets and centralizing the spares.

Other than the item categories, the study does not consider inventory related matters, such purchasing, sources, scope of inventory or inventory values. The study compares the costs of warehousing and transportation for inbound and outbound transportation to transit times to customers. The transportation costs and well as the lead times are calculated per standard road transportation. As for Metso, the suppliers for wear parts are situated both in Europe and overseas, the avoid changes in suppliers effecting on the gained results only the transportation leg within Europe is calculated to the costs. In practice for suppliers located in Europe the transportation costs are calculated from door to door, whereas for suppliers located outside Europe the transportation costs are calculated only for the last leg, meaning from destination port to destination door.

3.2.2 The study process

Within this chapter the focus is more in detail in to the steps carried out for the study: data collection, baseline validation, strategic framework, scenario definition and modelling and determining optimal solution, as well as the tools used carry out each step.

3.2.2.1 Data collection

Data collection was agreed to carry out in a way that Metso provided the data following information requirements set by external party. The data was agreed to be gathered over one year period from June 2016 to May 2017. The period was decided, as transactions over that period are already finished and orders shipped overseas received to listed warehouses. The data consists of inbound and outbound data, including order lines with dates together with transportation data. The key target is to ensure that references for shipments, deliveries and orders are linked to be able to relate information for transportation back to order line level.

For supporting data material list for included item categories with measures and weights, packing materials, vendor list and installed base for sold machines in scoped region is gathered. The figures managed throughout the study are focusing on net weights of the materials as well as purchase order or delivery lines. In terms of transportation additional 5% has been added to net weight to cover packing material weight. The data was extracted from SAP and Every angle utilizing SAP data and Cube gathering data from transportation service vendors and the transportation management systems utilized by Metso.

3.2.2.1.2. Inbound data

Inbound data is gathered from purchase orders (PO) placed for vendors known to supply materials for the set item categories. The inbound data is gathered from wider time range, to be able to use the data for the study for shipped PO lines from the defined period. The vendors included to the study are split into internal and external. The data available for each differ in terms of how orders are confirmed shipped and what kind of handling unit and shipping details are available. The vendor details, as well as material dimensions and

weights were provided separately. For stimulation purposes, later a share of PO lines received from each supplier is defined.

In addition to PO numbers, items and their quantities by order line the basic information includes vendor details and destination addresses as well as delivery terms and mode of transportation used. The rest of the information differs between external and internal vendors, mainly because for internal vendors each order is processed as normal outbound, whereas for externals the information is only about goods confirmed ready to be shipped and once they arrive to warehouse.

For external vendors, the PO data included to the study if the confirmed ready date is between the period from June 2016 to May 2017. As there is no shipment information available, it is assumed that PO lines confirmed ready on one day are form one shipment. The transit time is calculated to be the time between confirmed ready date and received date to warehouse. The weight of each shipment is calculated to be net weights per materials shipped with an additional 5% to cover packaging.

For the PO lines from internal vendors' PO data included to the study if their post good issue (PGI) dates fit to the data range. As outbound data is available for the internal PO lines shipment level information on the PO lines per shipment, as well as the transit times and shipment gross and net weights were available. The transit time is calculated from PGI date to received date to the warehouse.

3.2.2.1.3. Outbound data

The outbound data consist of order lines that have been shipped out; the PGI date is between June 2016 to May 2017, from scoped warehouses. As the scope of the study is limited to Europe and Nordics, only shipments with a destination country in these regions is part of the data. The outbound data is also split into two: outbound and internal. Internal stands for flow between warehouses and to internal production sites, whereas the outbound focuses on the scoped flow to end customers.

The order line part of the data builds up similarly to internal PO data; shipment level information that has relations back to order lines, and gross and net weights per handling unit and per shipment is listed on the data. Each individual customer is identified with an

individual number and delivery address is defined on postal code and destination country level. In the outbound data, dates from order creation to PGI are available.

Unlike for inbound data, where quality and relations from shipment data to transportation data is not decent, about 95% of outbound shipments related to transportation data. Therefore, transportation related dates booking to pick up and pick up to delivery are available and per actual performance.

3.2.2.1.4. Warehousing costs

Gathering the costs for warehouse proved to be more complicated than expected. As costs for warehousing are completely known due to differences accounting structure, due to which assumptions and rules to fill in the gaps had to be made in both transportation and warehousing costs. Some of the warehouses used are Metso owned, some used together with production facilities and some external the costs of the DC or satellite warehouse cannot be defined easily.

To calculate the baseline costs for the current warehouses, the invoicing structure used for the main DC, operated by Ceva was applied. The cost for fixed costs per square meter, through put tons, orders (deliveries) processed is defined together with additional cost for outside areas, where majority of wears are stocked. The labor costs are calculated for assumed productivity and processed orders referring to costs per FTE (Full time equivalent). These costs are then applied to known information from existing warehouses – the applicable space known and used and shipped order lines as shown on figure 4. Warehouse costs.

Warehouse premises	FI03 Tampere (FI)	SEDC Trelleborg (SE)	SE04 Gällivare (SE)	NO01 Stokke (NO)	GB01 Rugby (UK)	FR01 Macon (FR)	ES01 Madrid (ES)	CZ03 Perov (CZ)	FIH1 Born (NL)	TOTAL EUROPE
Inside space (m²)										
Inside space utilization (% full)										
Outside space (m²)										
Outside space utilization (% full)										
Labour cost WEARS for year										
Facility cost WEARS for year										
Annual throughput INTERNAL (tons)										
Annual throughput OUTBOUND (tons)										
Annual throughput TOTAL (tons)										
Annual deliveries INTERNAL (number)										
Annual deliveries OUTBOUND (number)										
Annual deliveries TOTAL (number)										
Labour cost / FTE										
Deliveries / FTE										
# FTE										
Outside Facility cost / m2										
Labour-cost index (Eurostat)										
Facility-cost index (CEVA)										
Minimum facility-size (m2)										
Annual Labour Cost										
Annual Facility Cost										
Annual Warehouse Cost										

Figure 4. Warehouse cost, baseline

For the stimulation purposes in later phases to define how change in the number of warehouses would affect the need for FTE or space required per warehouse. To get the need for FTE the throughput volumes are linearly extrapolated and rounded up to nearest full FTE. For facility costs the progressive extrapolation is used and extra 500 m2 added for handling area.

3.2.2.1.5. Transportation costs

The approach for the warehousing costs also consisted on known factors, combined with assumed values cross checked to known values. From Metso's side providing the transportation spend for this study is difficult as the transportation spend known consist of both the spend for wear and spare parts and cannot be split as they have been shipped on same shipments. However, as weight vice the share of wears is majority over spares approach is accurate enough.

For the transportation costs an annual spend from one country to another is provided for lanes that have been used on a country to country level and for each lane a ton kilometer value is calculated. Ton kilometer stands for a cost for thousand kilos for a kilometer in transportation. For the missing outbound lanes approach with an average value for ton kilometer 0,198 as shown per figure 5, Transportation costs below. The average value is then fine-tuned to general pricing conditions known in European road transportation and market differences.

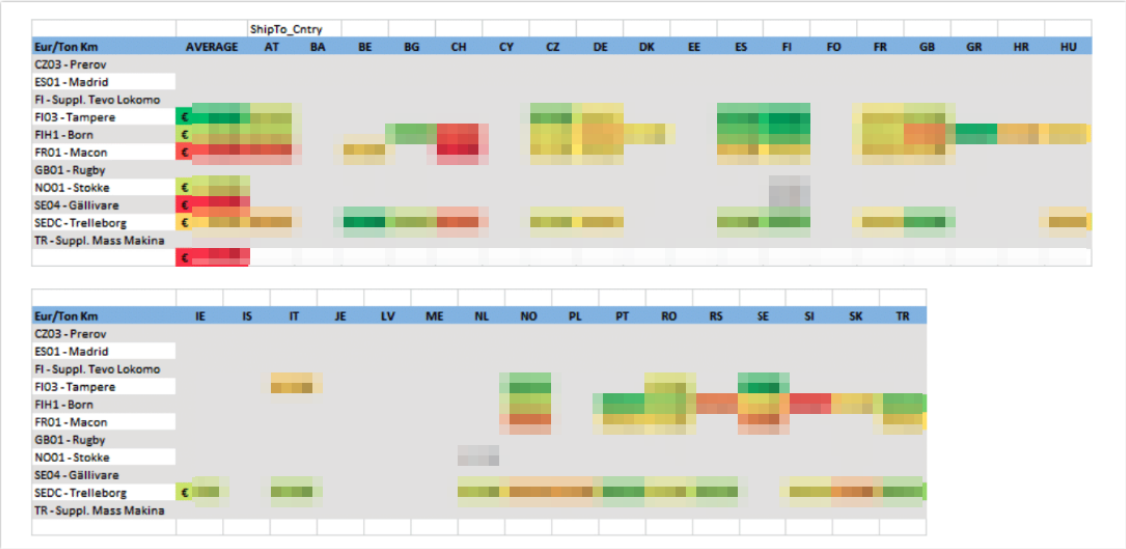

Figure 5. Outbound transportation costs

Inbound transportation costs are calculated slightly differently leaning on fact that majority of the inbound flow is delivered as a full truck load or as a full container, however cost per ton kilometer is also supporting. As stated the for the inbound transportation, only the leg from destination for to warehouse is in the scope, due to which all inbound transporflows as presented in chart 6, inbound transportation costs. The number of kilometers is calculated from distance between the supplier or used deep sea port to the destination warehouse. To ensure availability and lead times to each warehouse, which is a demand set by the business, minimal frequency from each supplier is a shipment every 2 weeks throughout the year.

Inbound flow type	Cost/tonkm	Cost/truck-km (13 Ton)	Minimal truck charge	Maximal truck charge
Turkey → DC				
Intra-EU (Non-Domestic)				
Domestic				

Figure 6. Inbound transportation costs.

3.2.2.2 Data validation

To goal of the data validation step was to compare if the data collected matched the business as we know it, whether the lines received or shipped matched to what they tend to be in real and if the cost structure gave similar figures to what is currently paid upon. To validate the correctness of the data collected during the first step the data sheets

provided were turned into visualized maps and graphs in ClickView. ClickView is a business intelligence tool that enables user to consolidate data from multiple sources to visualize, analyze and eventually interpret your business through it. During data validation imbalances and in clarities were seen, which eventually triggered a need for some of the data to be extracted again to improve the quality of it.

For the cost perspective, data validation meant creating rules and assumptions as not all data was available. The assumption taken in terms of transportation and warehousing are already defined in chapters 3.2.2.4. and 3.2.2.5. The transportation cost part therefore also required the most validation comparing cost of transportation lanes to ton per kilometer calculations made. As those turned out to be close enough and total spends turning out close to actual spend, the data could be validated to be correct. The warehousing cost part was impossible to be validated as majority of current WH costs are not known. The validation should however have been done more carefully, as the original assumption made turned out to be not careful enough as the logic behind them turned during later phases be showing impossible figures and having to create new calculation just before presenting final figures.

The data validation figures are presented as part of definition of current situation in company presentation later in chapter 4.

3.2.2 Baseline validation

Baseline is defined for two reasons; to check that the gathered data, calculations and especially the assumptions made corresponds to known situation and to use it in later phases for comparison against presented scenarios. Baselines created for this projects consist of defining where the customers are located, transportation flows and costs for warehousing and logistics. The graphs, maps and overall results of pictured as part of definition of current state in chapter 4.2.

3.2.2.3. Strategic framework

Strategic framework for this study was carried out together with scenario definition and modelling. The purpose of this step is to gain understanding of the business environment being and company strategy to gain basic understanding to which direction to take the

scenarios; how to align and support the supply chain strategy defined by the company into.

Within this study the strategy that carried out are customer centricity and idea of being able to deliver to customer within 2 days from dispatch with standard transportation option, in practice this means via truck. As inventory matters were left outside of the scope, inventory strategies were not included.

3.2.2.4. Scenario definition and modelling

Each scenario refers to an approach towards designing the supply chain network, here maybe slightly more how to define the distribution network. The scenarios start from defining again the current network, then calculates the optimal to get the values against which to compare. For this study half of the scenarios were made following on current warehouse locations and the other half greenfield, meaning that tool used is given tabula rasa, empty board to start from without any links to already existing locations.

The tool used for the scenario modelling is called CAST Aurora, which is a software that can be sued to support supply chain modelling, design and optimization. It works based on the given data and provides answers in graphs and maps according to requirements or approaches given for it.

3.2.2.5 Determining optimal solution

The determination on the optimal solution was already briefly referred to in previous chapter, as part of scenario modelling. For this study, it relates more to creating the final presentation together with, not only to optimal, but for the external party to give out their recommendations. The optimal may not be the same as the best and therefore the recommended option, as it may include factors that was not seen in the data, such as assumptions over inventory levels. The last step also included preparing and presenting the results and external party's recommendations for the steering committee.

4 CASE STUDY: Metso Minerals Optimal Distribution Channels within Europe and Nordics

The study carried out aimed to find answers to questions what is the optimal distribution channel; how many warehouses and where should they be located so that customers would be served according to set promises. The aim is not to create an implementation plan, but to raise discussion and provide a view in the eyes of an outsider and that wat challenge to think next steps from a different angle. When using the word optimal within the study it stands for lowest possible cost from warehousing and inbound and outbound transportation, value gathered from distribution strategy. The set promises for the transportation lead time is to reach 95% of all customers within [redacted] days from dispatch. Distribution channel strategy targets to simplify the distribution chain, making the chain more customer centric and that way enable to promise shorter service level agreement and to carry it out.

Within this chapter the case company and the current state of the distribution channels is presented alongside of the values gathered from the base line validation. After current situation is defined, the scenarios drawn during the study are presented to support on set strategies alongside with calculations for each. In the end of chapter the results presented by the external party are presented.

4.1 Case Company: Metso Minerals Inc.

Metso is a world leading industrial company serving the mining, aggregates, recycling, oil, gas, pulp, paper and process industries (www.metso.com). Company's focus is on helping its customers to improve their operational efficiency, reduce risks and increase profitability by utilizing its unique knowledge, experienced people and innovative solutions to build new, sustainable ways of growing together. Metso is listed on the NASDAQ OMX Helsinki, Finland, and had net sales of about EUR 2.7 billion in 2017. The company has over 12,000 employees in more than 50 countries (Metso Annual Report 2017).

During the study Metso overcame an organization changes from being divided into 3 business areas, into 7. The in the beginning the areas were Minerals Services, Minerals Capital and Flow control, all support market areas and naturally customers, that means

that from customer point of view there can be three different Metso's all providing expertize in different areas. Capital business area work in the field of aggregates, Mining and recycling, which means that they deliver complete crushing machines and other project type deliveries and support the recycling side. Minerals Services then works on aftermarket side, providing not only wear and spare parts, but also life cycle and repair services. Flow Control focuses then on a separate line of business than construction, meaning oil and gas and pulp and paper.

Over the project duration Metso's organization changed to include 7 business areas, separating the wear parts defined to be in scope to form their own Business Area – Minerals Consumables. Distribution of the wears remained still under Minerals Services business area, which means that the Consumables are purchased and distributed to customers through Distribution and Logistics supply chain. After the organizational change the spare parts remained under Minerals Services.

Distribution & Logistics (D&L) is part of Minerals Services and responsible over the logistics management and distribution chains, including the warehousing and transportation activities, together with operative actions related to purchasing, quotation, customer service and transportation. The logistics strategy the study follows, is from Distribution and Logistics.

4.2.Defining current state of Supply Chain for Europe and Nordics

Within this chapter the focus is on the current structure of the Supply Chain and the distribution lanes used. The focus is, according to scope of the study only on wear parts. First part focuses on current warehouse locations, where with the current set up, there are 3 different type of warehouse locations within Europe; DC's, Satellite warehouses and service work shop. Next chapters focused on distribution lanes used, inbound and internal lanes used from suppliers. In the last part, more on metrics; service levels and transportation and warehousing costs. The figures used are from study and were validated to form a picture of the baseline. All created maps, graphs and values for baseline validation are available in Appendix 1.

4.2.1 Current warehouse locations

The current warehouse locations are shared into 3 different types per to their service scope and owners to DC's, Satellite warehouses and service work shop. The locations are pictured on map in Figure 7 with the reference to their sizes according to weight of wear parts distributed towards end customers. Each of the warehouse stock both spare and wear parts, but the regions in question are moving towards centralizing all spare parts to central warehouse in Born.

The central DC, that supports customers globally is in Born, Netherlands is the largest in terms of weight of wears shipped, as shown in Figure 7. Born is also globally Metso's largest in terms of order lines, including both spares and wears. Other Distribution Centers in Europe Maçon, France and Prerov, Czech Republic. In Nordics, DCs are located in Trelleborg, Sweden and Tampere, Finland. These DCs are slightly more focused on local support, but as DC carry slightly different inventory range they do distribute all over. The different inventory ranges as due to historical reasons machine types supported by each country. DCs are under D&L responsibility.

Satellite warehouses are also called market area warehouses and are not directly under responsibility of D&L organization. They carry a smaller stock defined critical for customers within their region and supporting maintenance and service functions within their areas. Norwegian customers are supported from Stokke, United Kingdom from Rugby, Spain from Madrid. Service workshop in Gällivare, Sweden is focused on serving few key customers in Northern Sweden.

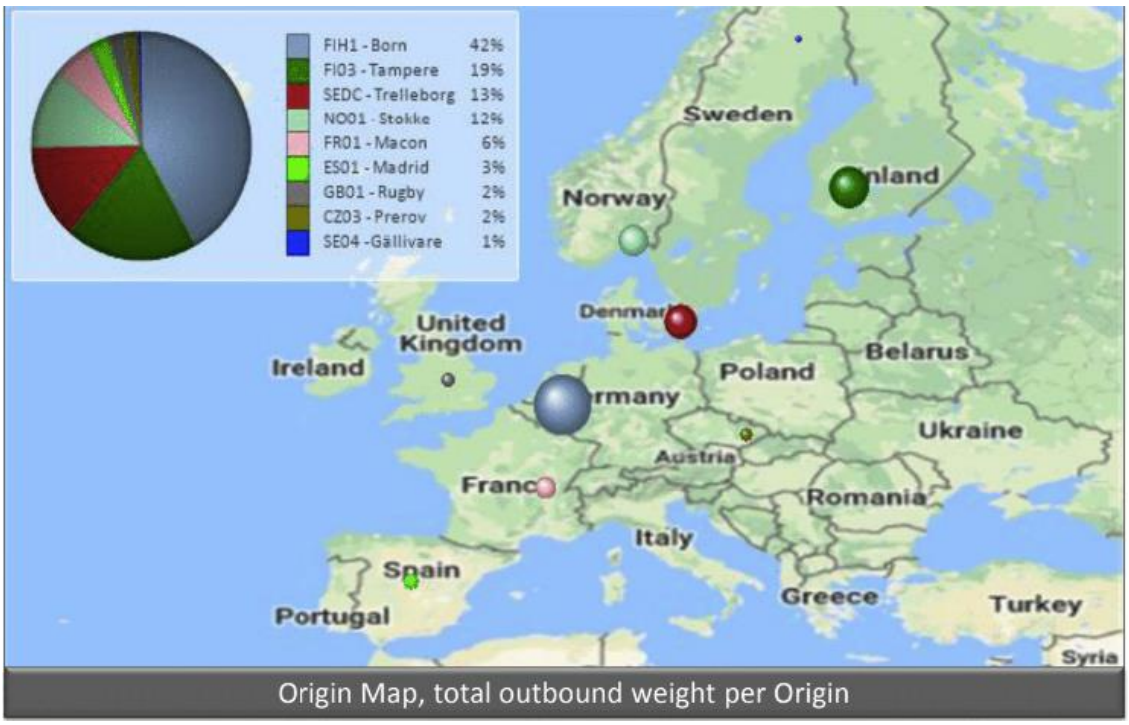

Figure 7. Current locations

4.2.2. Current ship to locations and distribution lanes

Figure 8 presents customer locations as ship to destinations on post code level from each warehouse. The figure presents how the end customers are situated on the map and where the customer density is the highest. The Figure is according to number of deliveries, similar figure according the total weight number is available in Appendix 1, as well as individual figures from each warehouse and well as an analysis of customer density.

As shown on figure 8 there are notably less customers in Eastern Europe and northern parts on Norway, Sweden and Finland. Simultaneously it can be seen, that sizes of the bubbles are notably larger in the Nordics and towards port locations in western boarder of Europe. The port destinations can be explained by customer orders consolidated to ports with a final destination overseas. The rest of the larger bubbles relate to larger quarries and consignment stocks, whereas the smaller ones are customers working on construction business.

The color of the bubble states the source of the shipment. The DC location Born, Macon and Trelleborg distribute around Europe and Nordics. Prerov and Tampere DCs are supporting on more local area. Satellite warehouses are strictly country specific, which

can most likely be seen in Spain, where none of the deliveries from Madrid reach Portugal, even though they would be the closest source for Portuguese customers.

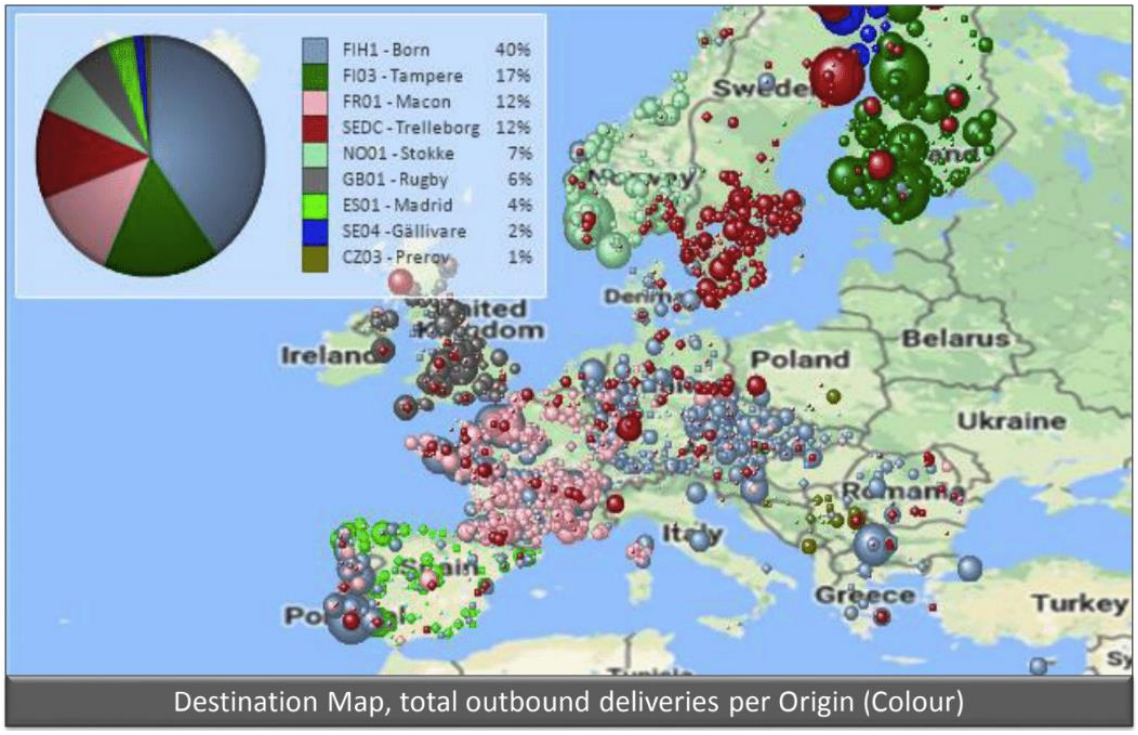

Figure 8. Customer destinations according to number of shipments

4.2.4 Supply Lanes

This chapter describes the current lanes purchased wears. Within the study, it was not wanted to focus on from where the materials were purchased, therefore the scope considers ports in Europe as a supplying location in case the supplier location is overseas. The supply lanes are divided in two separate ones; from suppliers and internal transportation from DC to DC or DC to Satellite within Europe and Nordics.

Figure 9 shows the origins by the share of kilos received and the warehouse where materials are received. Per receiving location, warehouses in Born, Tampere and Prerov receive almost all of the volume from suppliers. It can be explained by Born being the central warehouse and Prerov and Tampere being on a same site together with foundry operation producing wear parts.

Ship from location means the supplier locations in figure 9. Half of the volume origins from Turkey or overseas. Overseas suppliers show as the closest port for receiving

location, meaning the origin for Antwerp is the closest port for volume to Born, Kotka to Tampere. Malmö to Trelleborg, Themes to Rugby and Le Havre to Macon.

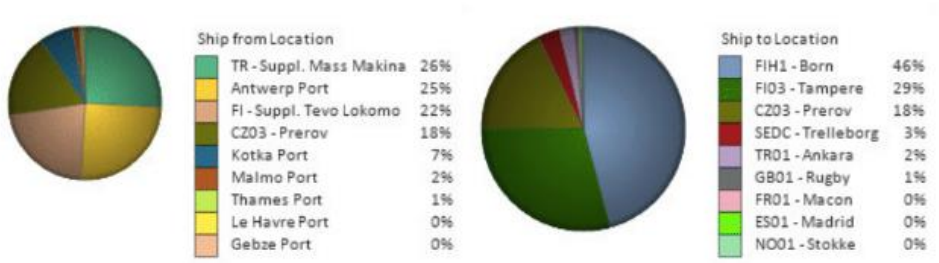

Figure 10 pictures from which supplier location the received locations origins from. Earlier mentioned statement that Tampere and Prerov are on same site as a supplier can be seen from large share of volume received from supplier close by. The volumes to Born are from the Turkish supplier or overseas.

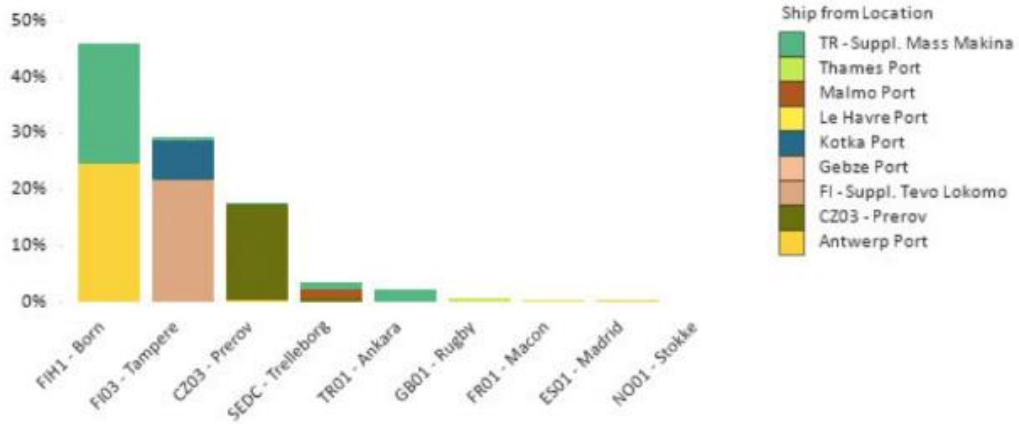

Figure 10. Supply lanes per weight

The receiving is currently done only to few warehouses, whereas the deliveries to customers' pictures in Figure 8 are shipped from each of the warehouses. This results in internal deliveries between the warehouse as shown in Figure 11 below. The largest supplier for all warehouse in internal transportation is Born warehouse, second in Tampere and third Prerov. Statement is therefore that wear parts often go through 2 warehouses in Europe or Nordics before reaching the end customer.

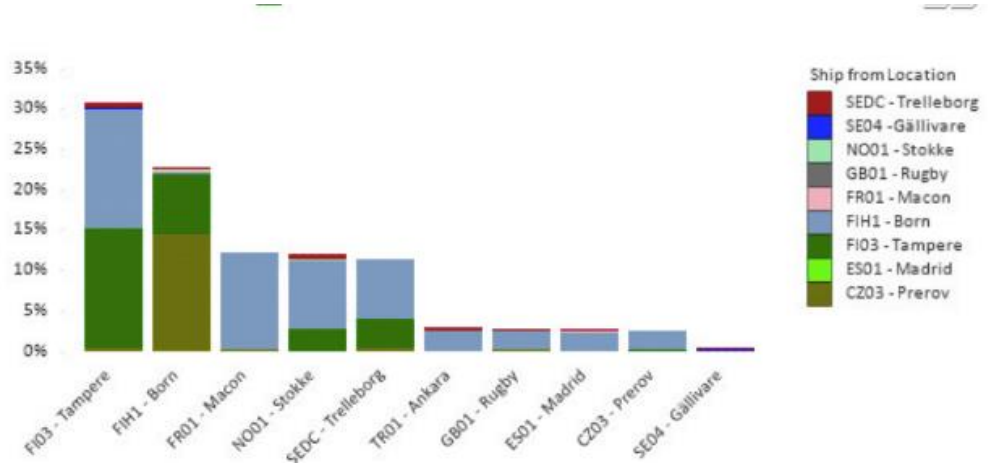

Figure 11. Internal Supply lanes

4.2.5. Service level

Metso measures their customer service level from order received to delivered. In history, the service level agreement given to customers has been [redacted] days for stocking items, regardless of the distribution lane used. As this study focuses on transportation part, not order entry or warehousing activities, only the average time used for transportation is pictured in figure 12. The figure states average transit times to each destination country, average transit times per warehouse and how big of a share deliveries have been made within a certain number of days. Metso has set a target that 95% of customers should be reached within [redacted] days' transit time, therefore [redacted] days is used as a reference.

From the figures, it can be seen that [redacted] days' target is not reached with current distribution channel set up, not to any of the countries nor from any of the warehouses. Looking at the distribution lanes in Figure 8. the figures in presented below could be expected.

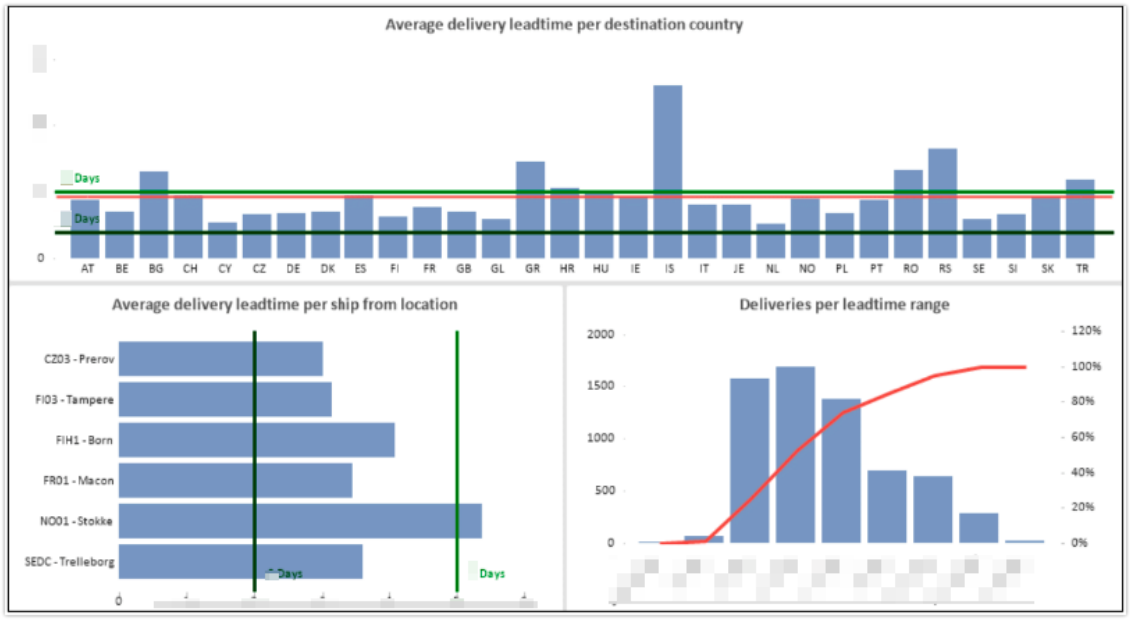

Figure 12. Delivery lead time per destination country

4.2.6. Transportation and Warehousing costs

Defining the current state of spend currently used for transportation was the most difficult part of defining the current state and therefore also validating the baseline. From the transportation, not all costs are not following same costs center structure and from warehousing point of view some are Metso owned, some shared and rest follow different cost center structure. Therefore, the current state on cost perspective is more of a presentation of baseline, instead of actual current situation.

Figure 13 presents the total costs for each warehouse, including inbound transportation from different sources and from internal transportation, warehousing costs for labor and facility and from outbound transportation. The cost follows the volumes received and shipped, Born forming the largest share of the costs. From the internal transportation point of view, the costs are paid by the shipping location, according to the incoterm used. The total cost during the gathered period is therefore agreed to be [redacted] M€.

Warehouse premises		FIH1 Born (NL)	FI03 Tampere (FI)	FR01 Macon (FR)	SEDC Trelleborg (SE	NO01 Stokke (NO)	GB01 Rugby (UK)	ES01 Madrid (ES)	SE04 Gällivare (SE)	CZ03 Prerov (CZ)	TOTAL EUROPE
Inbound Transport from Ports (Non-Scope)	€										
Inbound Transport from Suppliers (Non-Scope)	€										
Inbound Transport from Ports (Scope)	€										
Inbound Transport from Suppliers (Scope)	€										
Warehouse Labour Cost	€										
Warehouse Facility Cost	€										
Internal Transport from WH to WH	€										
Outbound Transport to Customers	€										
Total Baseline Cost	€										

Figure 13. Transportation and warehousing costs

5 RESULTS

The results gathered from the conducted study are listed within this chapter. The results were presented to Metso by first presenting how distribution flows could be by using as-is locations and stimulating customers from nearest warehouse in comparison to current distribution flows. Next scenarios are greenfield in terms of approaches, meaning that suggested locations did not need to consider ones already exiting. The greenfield scenarios compare to optimized set up defined in as-is scenario. First greenfield scenario considers how many warehouses would be needed to deliver customers within the set lead time target. For the second scenario considers center of gravity in term of volumes delivered to customer locations and how does that change based on number of warehouses. Last scenario returns to existing locations by reducing the number of current locations.

Each scenario is presented with a map and cost calculations. They are all listed in appendix 2, to support the ones presented within the results. The results are all presented without consideration how the inventory related matters or known business or operative limitations would affect on the results, as they were knowingly not listed while doing the study. Next chapter, conclusions, will focus on results with more analytical approach.

5.1. As-is locations delivered from nearest warehouse

First scenario compares current distribution flows, the baseline, and the how the flows would look like, incase customers would be served from the nearest warehouse instead of current more centralized approach. The figure 14 shows how customers are reached with current distribution flows. According to calculations made, 78% of customers can be reached within [redacted] days with standard transportation methods. An additional approach was taken also to exclude customers that were delivered only once from a warehouse. This calculation was run to see how much exceptional distribution lanes used affected on share of customers delivered within [redacted] days. By excluding customers that were delivered only once from a warehouse 82% of customers could be delivered within [redacted] days.

Considering Figure 17 more in detail, with the calculations made 50% of current customer locations could be delivered within [redacted] day and for 28% the delivery time with current

distribution lanes. With [redacted] days' transportation lead time 99 % of customer locations could be reached.

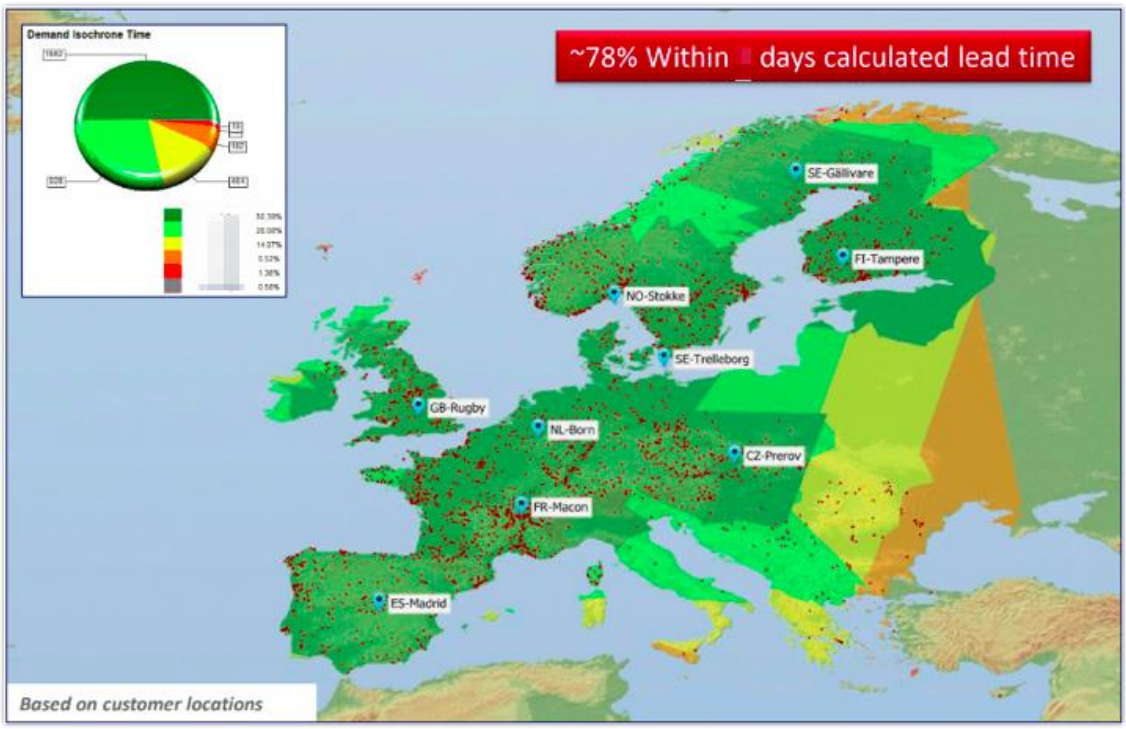

Figure 14. Lead times with current distribution flows

The scenario run to see how changing customers to get their wear parts from closest warehouse, instead of currently assigned one 98% of customers could receive their goods within [redacted] days' lead time. As presented in figure 15 already more than 91% of all customers could be delivered with [redacted] day lead time and about 7% with [redacted] days' transit time. More than 99,9% of customers could be reached within [redacted] days. The customer located in south-eastern Balkans and north-eastern corner on the Mediterranean are the hardest to reach.

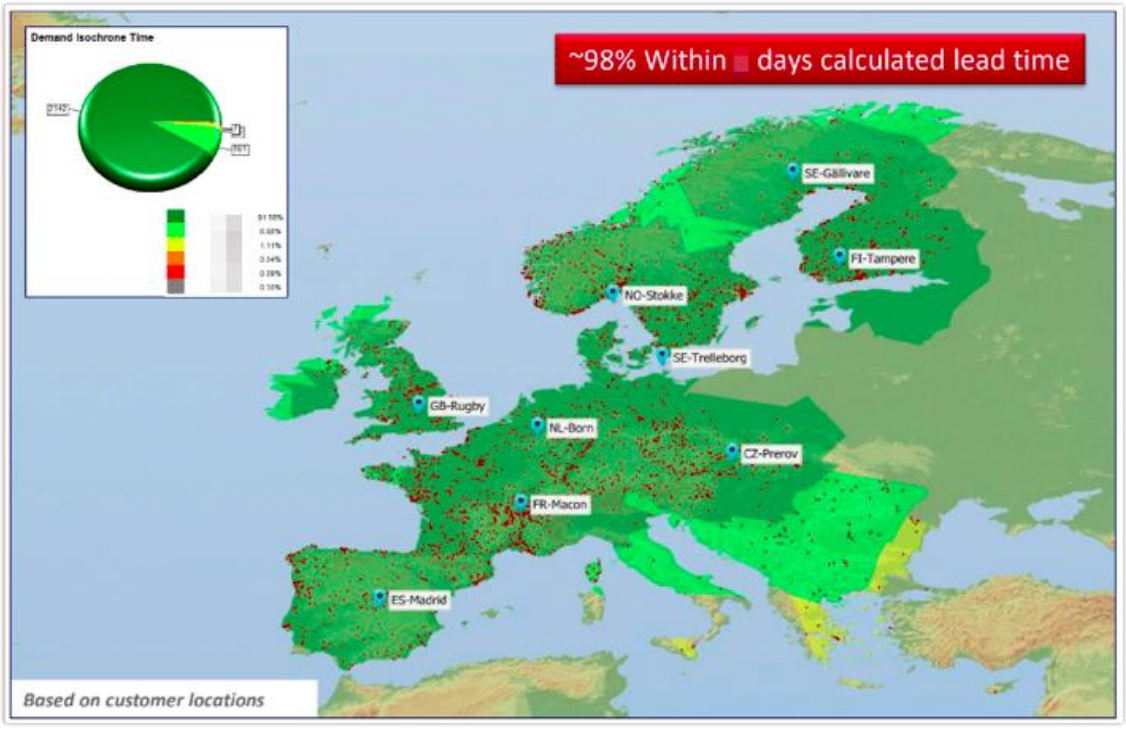

Figure 15. Distribution flows by using the nearest warehouse

Figure 16 below presents the lead time and the cost comparisons drawn based on the baseline model and the optimized solution with delivery from the nearest warehouse. The lead time comparison highlights how much faster the customers could be delivered in the wears would be delivered from closest warehouse; almost as many customer locations could be delivered within [redacted] day from the nearest warehouse, what now can be delivered within [redacted] days.

The cost comparison presents savings of close to [redacted], as seen in figure 16. The savings are gathered from in the internal transfers, as in this model also inbound would be delivered directly to local warehouse, instead of transferring majority of the wears parts through Born distribution center. The calculations also present major savings from outbound transportation costs, that would gather from shorter distances from warehouse to customer. Rest of the costs listed are close to same level on both, only the warehouse labor cost is higher on the optimized model.

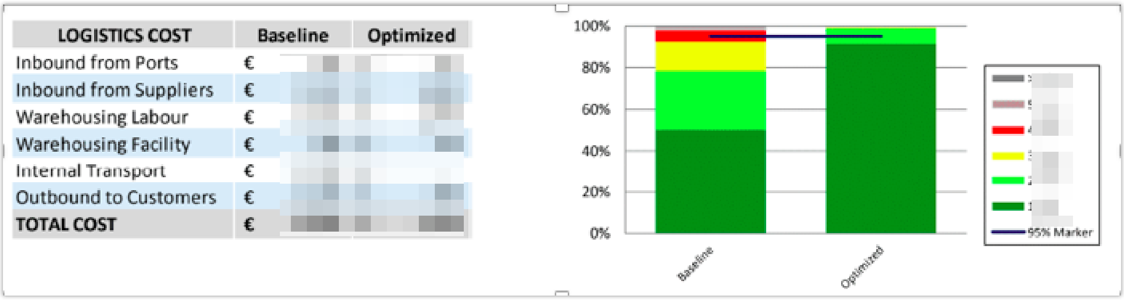

Figure 16. Cost and lean time comparison, as-is locations scenario

5.2. Warehouse locations with focus on lead time

First of the greenfield scenarios run models by focusing on following questions: how many warehouses would there need to be to reach customers in set number of days and where should warehouses be located to ensure the promised lead time. The model was run with target lead time changing from [redacted] day to [redacted] days. All different models can be found from appendix 2, and models for [redacted] and [redacted] days can be seen from figures 17 and 18. As [redacted] days' lead time has been given as target level to reach the customers, the share of customers reached within that time is used as point of comparison. The target level set is to reach 95% of customers within [redacted] days.

To reach 99% of customers within [redacted] day, there should be 18 warehouses in Europe and Nordics, whereas to reach the customers in [redacted] days, it would require 6 warehouse. As shown in figure 17 below the most notable change in terms of locations is that warehouse should be in [redacted] to support customers in Iberian Peninsula and other to [redacted] for the Balkans customers. UK and Western European customer would be supported from [redacted] and warehouse in [redacted] would support on middle European customers. Nordics would be supported from [redacted] and [redacted]y. With this set up 77% would be delivered in [redacted] and 22% [redacted].

Figure to present suggested WH locations and lead times

Figure 17. Warehouses if customers should be reached in [redacted] days

Between figures 17 and 18, calculation was made to see how many warehouses would be needed to reach the customers within [redacted] days. That calculations identified the need for 4 warehouses located in [redacted], to [redacted], [redacted]

and [redacted] The share of customer locations reached within [redacted] days is calculated to be 93% with this set up. As shown in figure 18, to reach all customers within [redacted] days only 2 warehouses would be required. The northern part of the regions in scope would in this setup be supported from [redacted]. The rest of Europe would be supported from [redacted]. The share of customers reached with [redacted] days' lead time with this set up is notably lower than with previous set up, the figure drops down to 74%.

Figure to present suggested WH locations and lead times

Figure 18. Warehouses if customers should be reached in [redacted] days

Figure 19 compares the results of the scenario models run to baseline and the optimized model. As stated earlier it would take 18 warehouses to reach all customer locations within [redacted]. In comparison to optimized model, where customers would be served from closest warehouse 98% of customers would be reached within [redacted] days, but only with 9 warehouses. Predicting on the costs for each set up presented in figure 20, the most practical set ups with accepted lead times are ones with 6 or 4 warehouses.

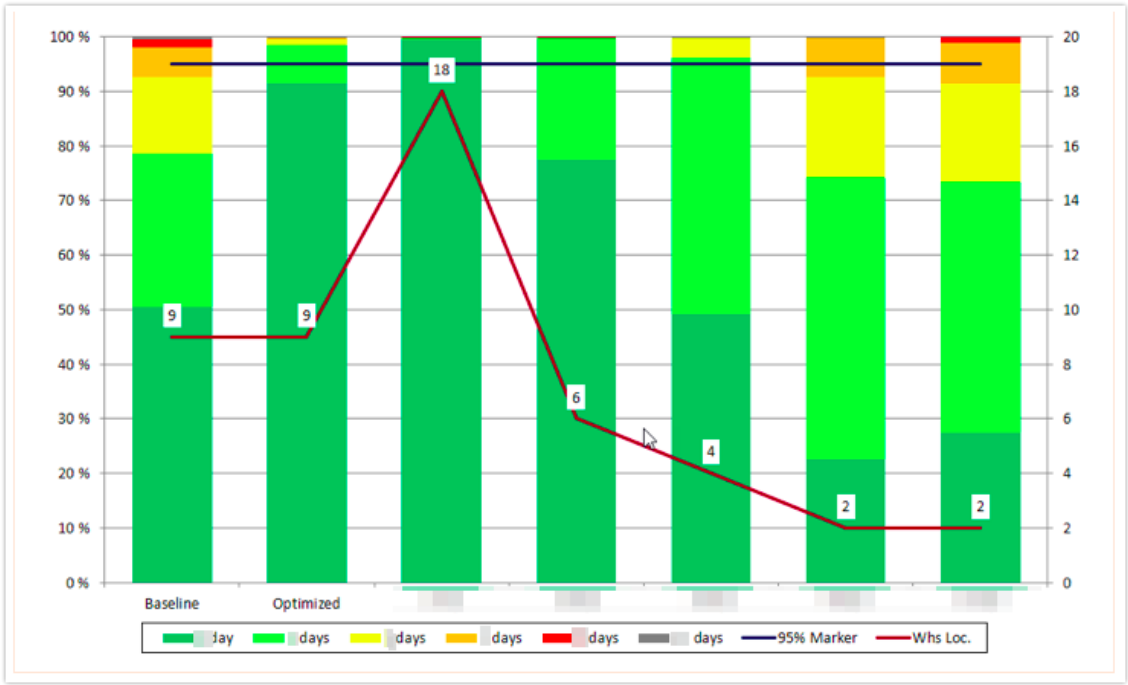

Figure 19. Lead time comparison of lead time centric approach to as-is models

The cost comparison done to match the lead time comparison presented in earlier figure presents the [redacted] and [redacted] days lead time models almost identical in terms of costs, with small

differences on outbound transportation and warehousing costs. Total costs with this model is close to similar as with the optimized model in the as-is scenario. The detailed calculations can be seen in appendix 2, whereas figure 20 presents the all-over graphs. In general, the cost follow rule higher the number of warehouses, the higher the warehouse cost due to location costs. Outbound costs reduce when moving warehouse closer to customers. Inbound costs remain on rather equal level apart from the [redacted] approach.

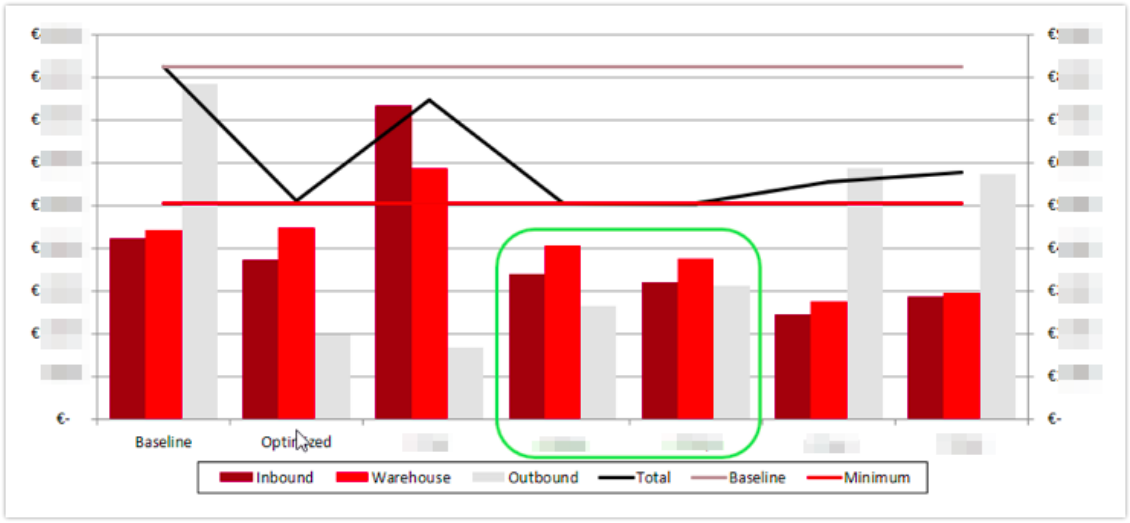

Figure 20. Cost comparison of lead time centric approach to as-is models

5.3. Warehouse locations per center of gravity

The second scenario run considered question given the change in number of warehouse locations changing between 1 to 10, how would the warehouse be to be located as customer centric as possible. The center of gravity (COG) calculation considers customer density and the number of deliveries made, giving the most frequently delivered post codes more importance than the less frequent. Below presented figures 21, 22 and 23 with 1, 3 and 5 warehouse locations. The rest of models run can be seen in appendix 2.

The calculations run showed that if Metso was to have only one warehouse to supply the wears in Europe and Nordics it should locate in [redacted]. As presented in figure 21 below, [redacted] is the most customer centric located within the defined region. From one warehouse 64% of customers could be reached within [redacted] days. However only about 18% of customers would be reached within [redacted], 47% with [redacted] lead time. All customers could how ever be reached within [redacted].

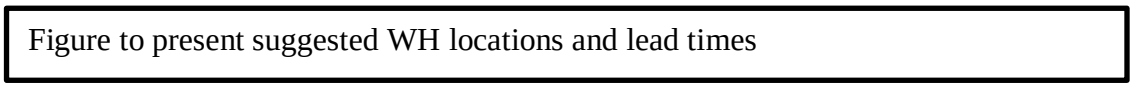

Figure 21. Warehouse locations per COG if 1 warehouse

If the number of warehouses would be two, they would be in [redacted] and [redacted] and [redacted]. Two warehouses would enable to reach 88% of customer locations within [redacted] transportation lead time. Figure 22 presents the model with 3 warehouses located per center of gravity calculations. The model enables to reach the targeted level of 95% of customer locations within [redacted] lead time. The Nordic market would be supported from [redacted], Eastern European from [redacted] and the Western European market from [redacted].

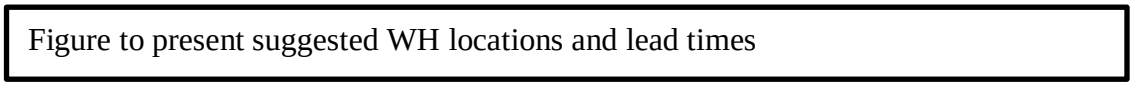

Figure 22. Warehouse locations according to COG if 3 warehouses

Continuing to run the model with 4 warehouses results that 96% of the customers could be reached within [redacted] lead time. There the Nordic locations would be located as they are in below figure 23 in [redacted] and [redacted], but the continental European would be located equal to figure 22 in [redacted] and [redacted]. Adding 5th warehouse to the model changes the locations to be located as presented in figure 23. Northern part of Europe, would be supported from 2 warehouses, [redacted] would continue to support Eastern Europe. Western European location would move closer to [redacted] to [redacted] and additional location would be added to support Iberica into southeastern corner of [redacted].

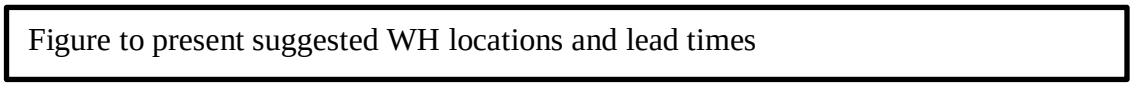

Figure 23. Warehouse locations according to COG if 5 warehouses

The lead time comparison in figure 24 shows that the differences between the percentages of customer locations reached within two days remain in rather same level regardless of the number of warehouses being 3 or more. Small differences are most likely due to majority of customers being located rather close to each other and also that the customer locations that are distant, are not high-volume customers as their effect on COG would then be more notable. From the comparison, it can also be said that the current

warehouses, if looking at the optimized model, are located quite well in terms of comparison to center of gravity model.

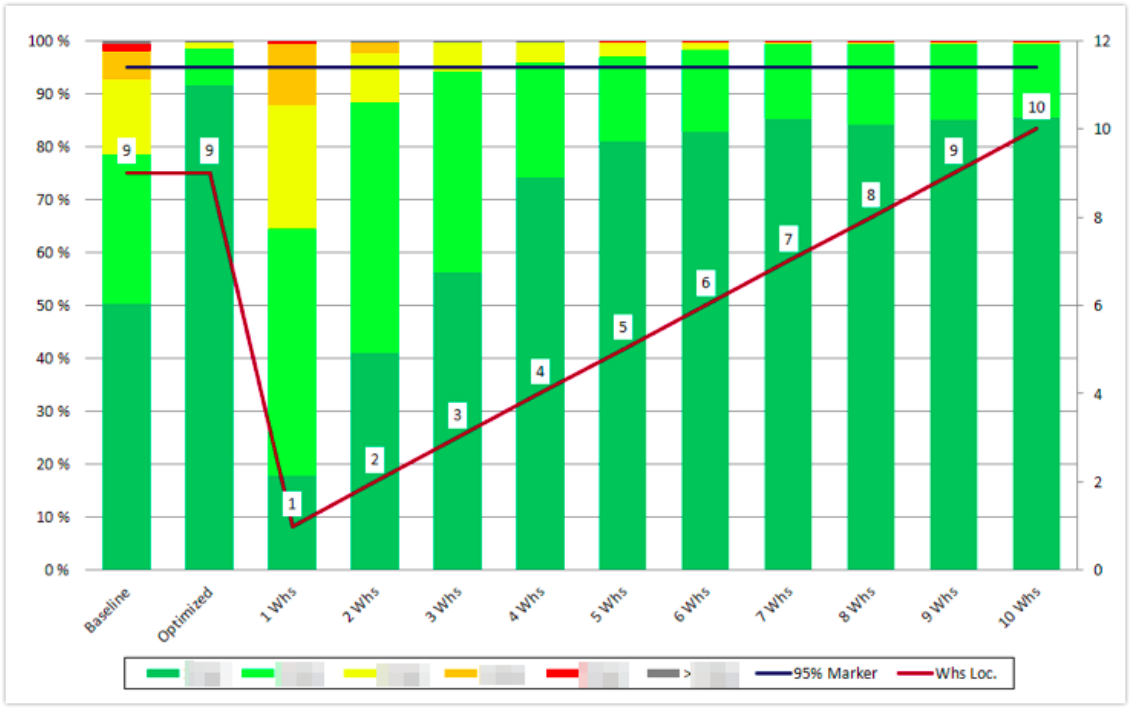

Figure 24. Lead time comparison of center of gravity approach to as-is models

The total costs calculated for each model remain quite close to same regardless of the number of warehouses. As shown in below figure 25, the lowest cost levels could be reached with 4 and 5 warehouses. The differences mainly come from warehouse facility costs, as inbound costs raise at the same speed as outbound costs go down as the number of warehouses grow. If comparing the optimized model to same number of warehouses, but located according to center of gravity, inbound costs are lower in the optimized model, but the outbound costs higher resulting COG model with slightly lower total costs.

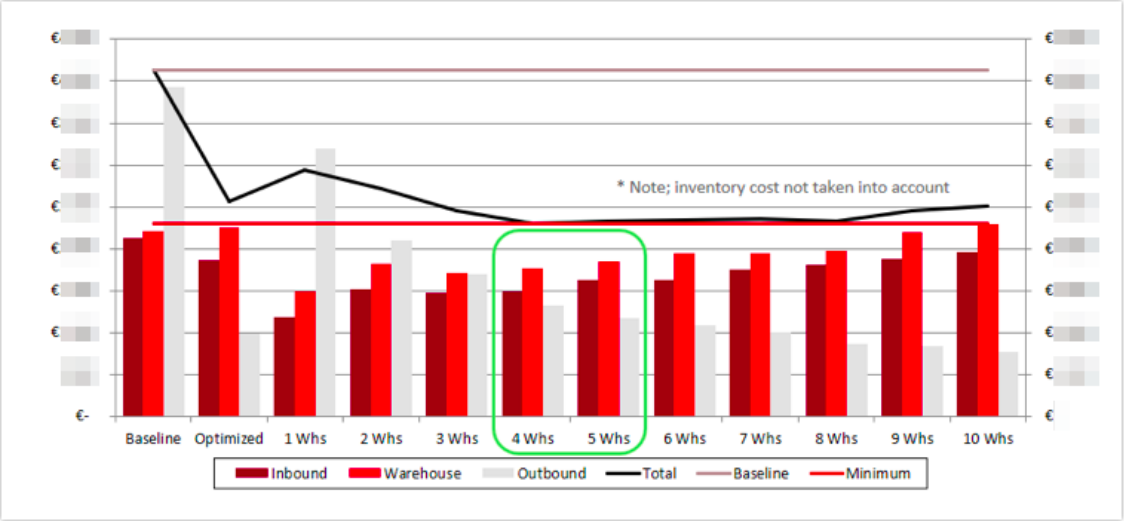

Figure 25. Cost comparison of center of gravity approach to as-is models

5.4 Reduction of current warehouse locations

The last scenario run focuses on reduction of current warehouse locations, by seeing how much would closing warehouse or warehouses effect on lead time to customers, as well as the costs. The scenario was approached with two separate logics; reducing warehouses according to their capabilities and other by closing the warehouses according to their effect on transportation lead time to customers. The maps for the second approach are presented in appendix 2, as the first approach is more applicable to business environment known. The assumption in these scenarios follow the optimized model, where customers would be supported from nearest warehouse.

The first model run for this scenario was how closing Stokke in Norway would affect on transportation lead times to customers. The calculations showed the same figure as it shows in below figure 26, where also Gällivare in Northers Sweden would be closed; closing of either would not effect on share of customers reached within targeted [redacted] days. 98% of customer locations would be delivered within the targeted lead time.

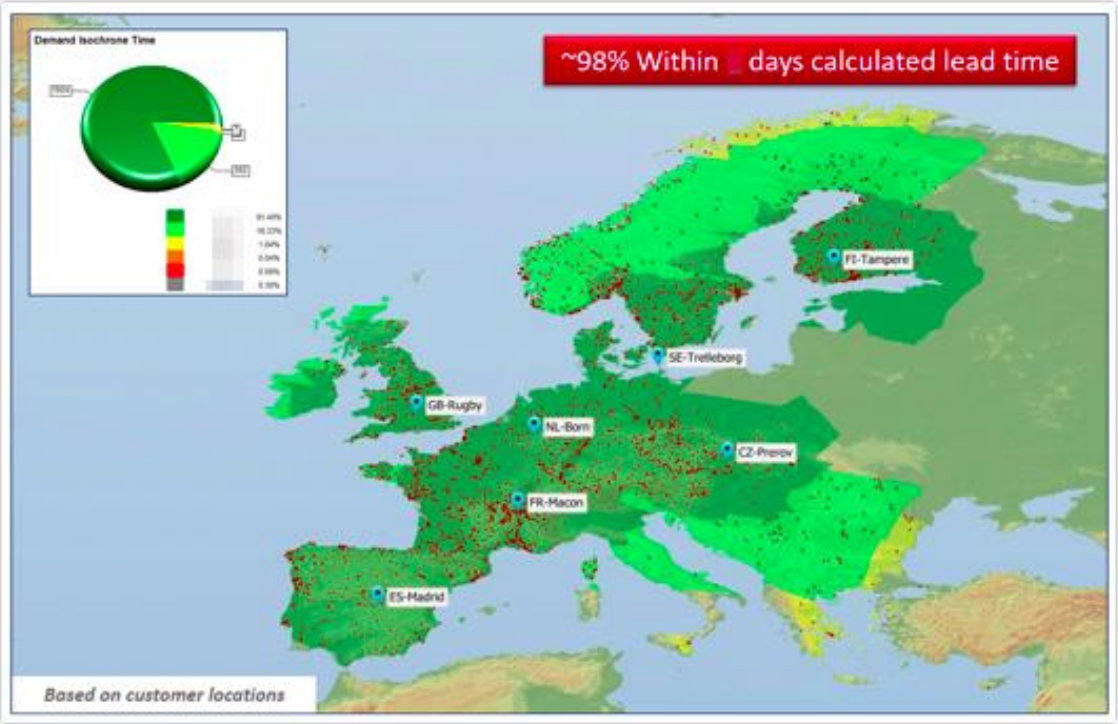

Figure 26. As-is locations, Stokke and Gällivare reduced

The 3rd location reduced was Rugby in Great Britain. As UK customers can be supported from Born, Netherlands within the targeted [redacted] days lead time, closing down Rugby would neither have an effect on share of customers reached within targeted lead time. Figure 27 presents how closing the last satellite warehouse in Madrid would affect on promised customer lead time, as with this set up 93% of customer locations could be delivered within the targeted [redacted] days. However, more than 99% of all customers could be delivered in [redacted] days. In the alternative model, where warehouses are closed according their effect on the share of customer reached within the lead time, with 5 warehouses 97% could be reached. In that scenario Stokke, Tampere, Prerov, Born and Madrid would remain.

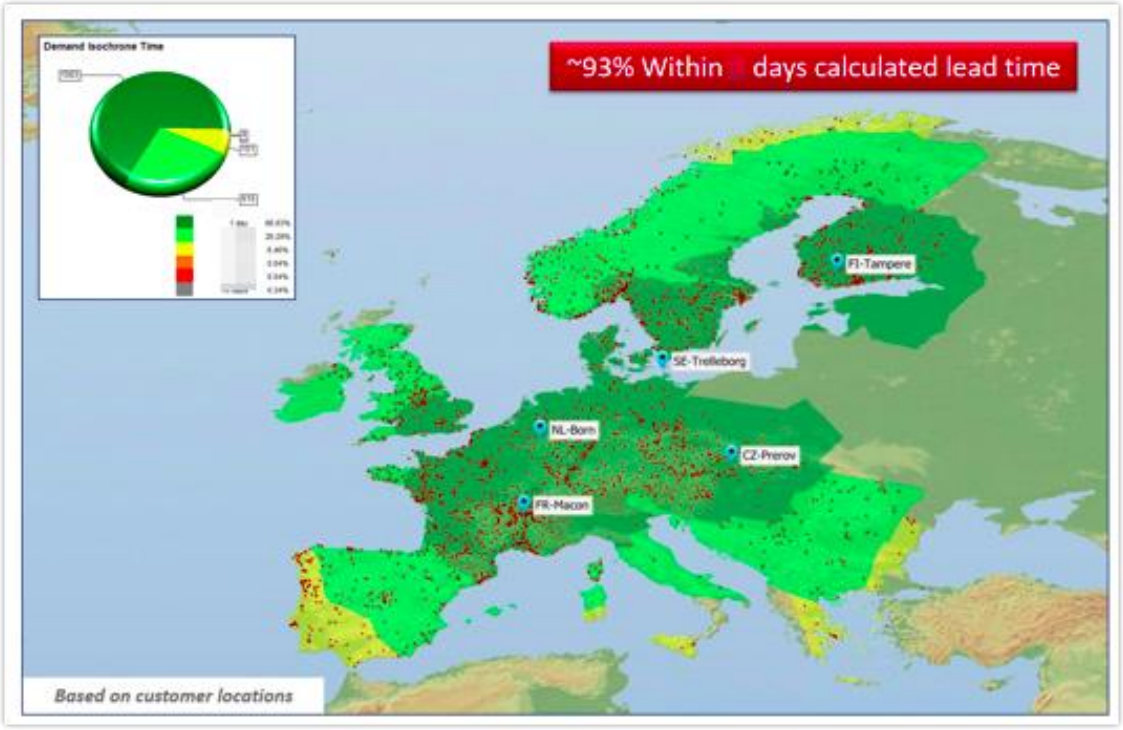

Figure 27. As-is locations, Stokke, Gällivare, Rugby and Madrid reduced

Figure 28 shows how in addition to closing the satellite warehouses and Gällivare, closing Macon would affect on lead time promise. Closing Macon would leave Iberian Peninsula almost completely out of reach within [redacted] days, leaving only 89% of customer locations to be reached within [redacted] days. However, still 99% of customer locations could be delivered within [redacted] days' transportation lead time.

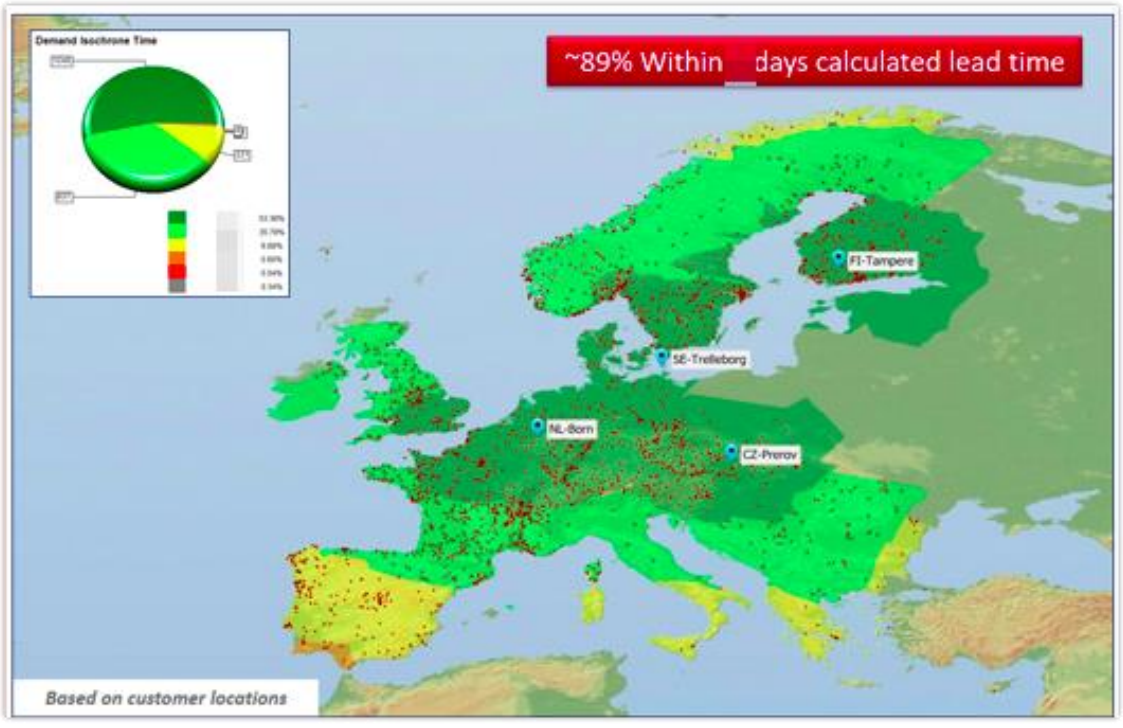

Figure 28. As-is locations, Stokke, Gällivare, Rugby, Madrid and Macon reduced

Lead time comparison pictured in figure 29 that 3 of the current warehouse locations could be closed before the targeted transportation lead time could no longer by fulfilled for 95% of customer locations. Comparison to baseline presenting the current distribution flows, by closing 5 warehouse locations the customers could be served with better lead times than currently.

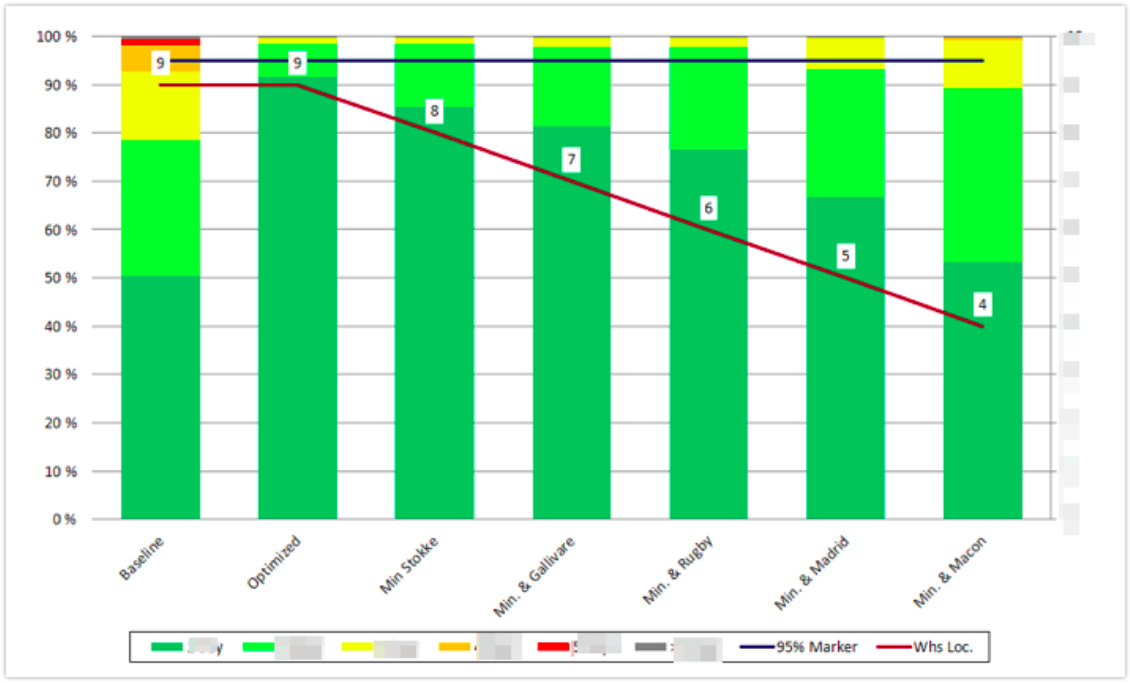

Figure 29. Lead time comparison reducing current locations

The cost comparison in figure 30 shows that most cost-effective option in terms of inbound and outbound transportation and warehousing costs with this scenario would be to reached by closing down Stokke, Gällivare and Rugby leaving Europe and Nordics to be supported by 6 warehouses. Reducing the number of warehouses further, would no longer decrease the total costs as outbound transportation costs start to raise as distances from warehouse to customers increase.

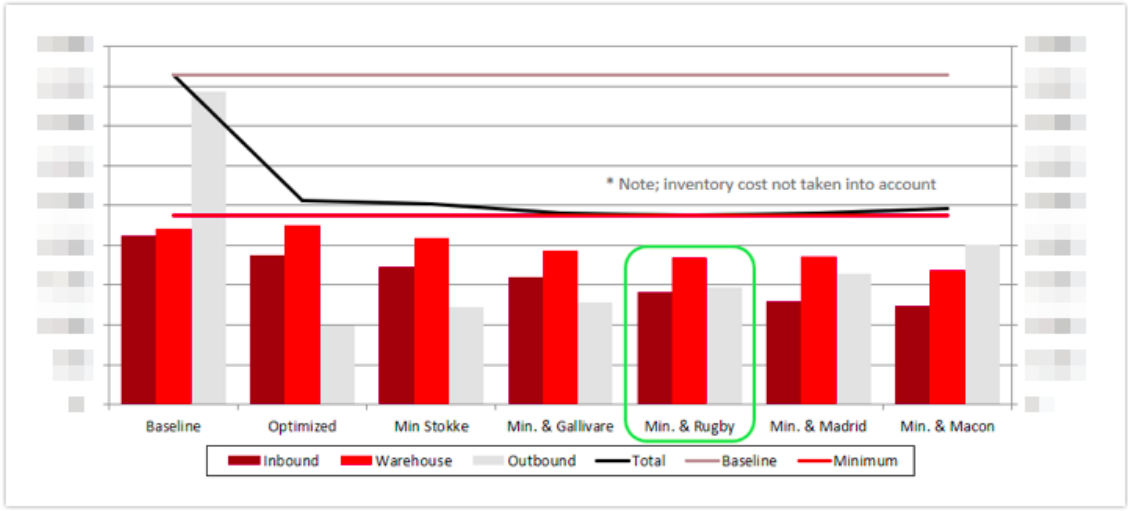

Figure 30. Cost comparison reducing current locations

6 CONCLUSIONS AND DISCUSSIONS

The last part of the conducted study was to provide recommendations and suggested next steps to be taken in behalf of the external service provider carrying out the study in co-operation with Metso. As the study was carried out without setting limitations, market environment or focus on current capabilities, factors that effect on business decisions in the know business environment, the conclusions are written by reflecting the conclusions given by the external service provider and setting those to match on the known environment. Also, as the focus of the study was much on distribution lanes leaving rest of supply chain structure on lesser or no attention, chapter on conclusions will also reflect on how suggested changes effect on supply chain as whole.

The research questions set for the study were to define what is the optimum number of warehouse locations within Europe and Nordics and where those locations should be. The solution suggested is wanted to be customer centric and therefore improving Metso's customer service level and speed of service. The choice of word optimal in the target setting leaves room for the question over what should optimal be. Optimal was interpreted to mean break point of cost and benefits; meaning the point where higher number of warehouses no longer showed as improved lead time, but only as higher costs. In practice, it often also means increased complications or difficulties in managing the built set up.

In the conclusions chapter begins with providing the recommendations on number of warehouses and supply chain structures. Next part focuses on how the changes would affect on customer service and the service levels promised, mirroring into metrics used. The chapter ends into recommendations to next steps and listing things that should be considered once planning to implements what is recommended and finally to evaluations on how the conducted study succeeded and how reliable the results are.

6.1. Optimal warehouse locations

The recommendations given by the external party summarizes into following factors: high internal transportation costs, complicated distribution lane structure and too high number of warehouses. Already looking at the differences in the lead times in as-is model and the optimized model the differences cannot be argued. The internal transportation costs compiling from using Born to distribute majority of the wears to DC's over the

regions creates fair share of the total freight spend. Current number of 9 warehouses over the region, is calculated to generate savings without reducing customer service levels. Annual savings potential of [redacted] to [redacted] is suggested referring to Figure 16 comparing as-is model to optimized one.

The recommendations given by the external party all start by stating that Metso's current distribution lanes are complicated and illogical with country limitations in terms of deliveries made as shown in Figure 8. They state that significant savings in terms of operational costs and lead time could be made by optimizing geographical areas supported by the warehouses. For example, by utilizing Madrid warehouse to support Portugal or Prerov to support all Eastern Europe notable savings could be made. Metso has started a project to improve this matter as it was realized that the wear parts should be brought closer to customers, as those are the ones that disable to reach the targeted service levels with the current centralized set up. However, I do believe that this study made raised a point on how strictly Metso is currently fixed inside country boarders in terms of supporting WH's. There must be a historical reason on why such exist, but given that Metso aims to perform as one Metso boarders should not effect.

The most notable share of the saving potential calculated come from internal transfer and how the inbound lanes from suppliers would change in case the closest warehouse would support the local customers and they would also receive the goods directly from the supplier instead of Born acting as distributor. The savings potential from the change is calculated to be [redacted] euros if the internal transportation would be fully eliminated.

Due to the bulky and heavy characteristics of the wear parts Metso aims to purchase all from the suppliers with full containers, due to it being the most economical option over whether the mode of transport is ocean or road. Target to build full containers with weekly flows from suppliers is also why the current decision on Born acting as central warehouse and distributing the wear parts to local warehouses. Metso has already taken actions to straighten the inbound flows by shipping directly to local warehouse without bypassing Born, they have noticed that volumes to each warehouse with the current do not fulfill the requirement per supplier to ship weekly full container, biweekly containers are planned. From customer point of view bi-weekly container adds another week to lead time from supplier and makes inventory planning more difficult.

However, as the already made calculations do not consider idea of reducing number of warehouses, assumption is that by reducing the number of warehouses would increase the volume to individual location. The calculations done for scenario 5a (Appendix 2) do also suggest that this would also decrease the inbound costs with about [redacted]€ annually, if only 5 warehouse would exist. As the inventory calculations were not part of the study, the inbound volumes are only assumptions and therefore calculations only provide room for assumptions, I do think believe that they provide enough grounds to consider the matter more thoroughly when taking next steps.

The external party states that Metso's current warehouse locations are well located. The recommendation given, is that optimum number of warehouses is 4, but it would require that each of those warehouses would be situated in optimal locations like ones modelled in scenario 4 (Appendix 2). However, as without inventory costs, the operational costs for 4 and 5 warehouses are close to same, the external party suggest to keep 5 of the current warehouses; [redacted], [redacted], [redacted], [redacted] and [redacted]. To consider inventory values and how they would affect on the costs, the suggestion is to locally stock the fast-moving items and centralize the slow and medium moving items to one place. This place is suggested to be Born as that has the best lead times all over Europe (Appendix 2).

The assumption in the beginning was that optimal locations would have been closer to ports as inbound costs for ocean freight form mainly from ground costs. With different scope in terms of inbound transportation and with more cost focused approach such results could have been different. As Metso's strategy drives towards customer centricity, the approach taken guides towards right steps. The steps that Metso has taken already is that wears from [redacted] have been moved to [redacted], which enabled [redacted] to receive frequent full containers from supplier as it would support two countries and lead times were calculated to be good enough. [redacted] also has good processes and space to support also Norway. The current premises in [redacted] are too small to support even the business in Norway, therefore it cannot be considered as an option for even more volume. Therefore, my recommendation in case of next steps, would be to consider location closer to Gothenburg and Norway boarder. Fact is that the largest customers in Norway have consignment stocks, so frequent fast deliveries are most likely not required. However, bringing the warehouse supporting Norway and Sweden would reach customers with better lead times, if it would be located a bit more

north in southern part of Sweden or even on the Norwegian soil. Gothenburg would also be a better located in terms of transportation hubs than [redacted].

As for the rest of suggested locations, [redacted] and [redacted] require improvements in terms of capabilities in terms of being able to support the markets within their reach. [redacted] is unknown, being a market area warehouse and would most likely need as much attention as establishing a new warehouse location. However, purchasing and customer service capabilities exist, but for example warehouse processes and alignment with Metso's transportation agreements are required. [redacted] even though it functions already as a distribution center, lacks behind in terms of processes and capabilities, improvements being done to premises will hopefully improve capabilities to add volume. [redacted] and [redacted] are already supporting the targeted markets, so in terms of capabilities the suggested change will not require changes.

In terms of costs calculated for the study, due to assumptions and ways to calculate the costs and therefore also savings potentials I would not dare to directly suggest that savings up to [redacted] € could be made. Also, not including the inventory costs will most likely make the breakpoints between the costs and benefits appear stricter than the ones now calculated, like in Figure 30. The calculations to me give more of ideas on percentage level and encourage to change. Also, as current warehouse related costs for [redacted], [redacted] and [redacted] are unknown due to Metso own premises, the savings potential might be even higher.

6.2. Customer promises

With its current distribution lane structure Metso struggles to receive the targeted [redacted] service level agreement for stocking items to its customers, as shown in Figure 12. The [redacted] includes everything from order received to delivered at customer's premises. The calculated [redacted] for transportation leaves [redacted] for each, order entry, warehouse processing and booking lead time, so that the [redacted] could be reached with the targeted 95% probability. Whereas with the current distribution lane set up [redacted] with seems unreachable, with the suggested more optimized set up, for example looking at Figure 29, [redacted] lead time seems perfectly reachable.

Looking at the lead times, they seem realistic compared to known situation, where majority of customer deliveries are made with groupage network. Even though the calculations groupage network and time consumed transferring through terminals, it does not consider that delivery trucks to certain destinations, like some of the Balkan countries, leave from the local terminals only once a week or to Portugal only few days a week, which are the known issues with the current set up. However, as the suggested set up is more local, the terminals or delivery trucks that the logistics service providers would use might differ. Writing the conclusion, I consider these matters worth identifying to pay attention to if taking next steps.

In terms of customer promises, the given promise on SLA should be something that applies to defined share of orders, regardless if customer orders spare or wear parts, or from where the delivery takes place. Customer should be served with Omni channel approach, meaning he/she orders goods from Metso, not from a specific warehouse. From Metso, this requires that order entry and warehouse processes function the same way, so that the service customer gets does not differ based on the warehouse.

The external service provider suggested that fast moving items should be moved to local warehouse and medium and slow moving should be kept centralized. The lead times from Born reach 63% (Appendix 2) of customers within two days. For the next steps, it should be considered if the scope of materials moved closer to customers should also include medium moving items. This would leave slow movers to be centralized and to my opinion ensure that promised service levels could be reached with good success rate.

6.2. Evaluation of the results

The hardest part of the study project appeared only when starting the present the results to Metso. As for myself the high number of assumptions and generalizations, that had to made already when collecting the data and drawing the baselines, forced to look the study from an aspect that no accurate figures that would not securely enough mimic the actual lead times or cost levels. The results in terms of figures would be giving only an idea of percentages how suggested changes would affect.

Presenting an approach of this type, to persons that look supply chain through figures and KPI’s, is not an easy task. Thinking what could have been done differently and better, is

that I should not have relied on myself to do the baseline validation as heavily as I did, no matter how familiar the topic is. This way, the part experienced to be the hardest would have most likely been easier. Another thing I would have done differently, is that the inventory aspect should have been brought along. To keep the scope still manageable, the approach should not have been to define the material scope for each warehouse to hold as inventory, but a general approach like define an inventory value per kilo or something alike. Within the study the approach partly loses the main idea of supply chain management over how every function is dependent to another.

In terms of results received, I eventually like that they do not fully reflect the assumptions I had, or the ones the steering committee had. The way I see it, is that already to see how customer locations, number of shipments or customer densities set on the map, brought along a refreshing view. My assumption was that the suggested locations would have been closer to ports, due to most inbounds arriving to ports. Now thinking, it most likely would have been, if the approach would have been something else than customer centric.

In terms of reliability of results, I do not trust that the standard network could cover 95% of customers from 5 warehouses in [redacted]. Nor do I trust the warehousing costs to be correct, I do not think the external party would agree to sign a contract with the used pricing principles. I however do think that the study managed to provide a look by an outsider and based on discussions it has raised, it succeeded to push people to think. However, as Metso relies firmly to structures and responsibility splits, to make a change more than a study is required to set real changes to motion. Based on statements made above, I don't think the way to grade success of the study on the actual reliability of the figures, but to open the discussion and show possibilities, most importantly it shows what it takes to be customer centric, the most important pair of words that the D&L strategy mentions.

Thinking what was targeted and what was the outcome of the study, I would not state this was a complete success. My perception has been that the steering committee would have wanted to get something more practical and something they could start planning for implementation for. However, I like the outcome and that it dares to state that you are doing good, your locations are good. Given that the external company is one that offers contract warehousing, suggestion on not to make changes is a sign of reliable result.

6.3. Recommendations for next steps

As the study included only analysis part, excluding plans to go forward to improve the Metso Minerals distribution lane structure in Europe and Nordics and that way improve the customer service. Some of the steps have already been taken as parts of an ongoing project, this chapter focuses on steps that should be considered in addition to creating a plan on reducing the number of warehouses and changing the supply lanes from supplier to local warehouses and to customer locations in terms of wear parts.

As stated in the previous chapter customers should not need to think which sales office or warehouse or entity they place their order into. Metso should be strongly pushing towards an Omni Channel approach and bringing all customer groups to order through one channel, through which Metso would internally have defined which warehouse should support the customer in placing the order. The same sales channel should apply regardless what they order from Metso, if it is service, spare or wear parts or even a complete machine. Thing to consider for Metso is to unify the concept of how they sell to customer, transportation part should be sold as part of service, following an idea that Metso ensures that goods are received within the time promised by the SLA. This would reduce the need for cater for individual customers, but does require that all sales organizations and customer groups would be aligned with the approach.

Same approach applies also in terms of how steps are taken within the process from order received to goods delivered. It is also the only way how to measure the SLA is a way that locations are comparable and customer service ensured. Within Metso this mainly concerns bringing all warehouses on the same level in terms of basic functionalities, tools and systems used in the warehouse processes. Currently the ways of working between the locations differ drastically, starting from processing times to fees over faster service or details like what kind of packing list is included or through which channel customer is informed, or even confirming the goods shipped. Important step is to align all steps with in the outbound process to follow same structured global way of working.

It is also known that transportation service providers used by the current satellite warehouses, such as [redacted], are not aligned with Metso's contracted LSPs. This disables to bring visibility advantages existing if named LSPs are used together with global booking processes and transportation management system used. Improving the customer

service, and managing performance as a company, the locally used logistics service providers should be evaluated and decided if contracts should be made with them and this way bind them to enable follow same process and use the same tools as rest of the contracted LSPs.

Running through the scenario 4 focusing on warehouse locations calculated according the center of gravity of deliveries done to customer locations and seeing customer density reducing towards east it brings up the question if all customers are worth the same. All customers do not order with same value and some require more outside of standard service leaving the profit generated on different levels. Should customers be graded per their importance in terms of profit they generate? The grading would enable to Metso to promise better of SLA for the customers with the highest grade by for example stocking inventory specific to their needs in the local warehouse, whereas the customers with the lowest grade could be supported from the central warehouse for all but fast moving items.

The study did not suggest all possible supply lane options and due to Metso's approach leaned heavily towards inbound shipments always to be full containers. Comparing the available prices between FCL and LCL, the price differences are not notable. Step to be considered would be to re-evaluate if it is worth to focus on using full containers for inbound or also utilize LCL. Considering that currently the handling in the distribution warehouse adds burden to material and internal transportation is proved by the study to be a cost from which savings should be made.

An alternative option is to offer customers an option to order material from Metso with a point to point model, where Metso combines orders from multiple customers and ships them to named port in a container and arranges a delivery from there on to individual customers. Alternative option is to use a concept called customer consolidation, where orders for multiple customers are combined to one container, managed by the seller. Difference being, that each customer's order is treated with transportation scope of door to door, whereas in point to point it is door to destination port and individual shipment from destination port to destination door.

All in all, to summarize the findings from the study Metso does require changes in the way the distributions supply chains are carried out currently. The results of the study provide guidelines for a vision how the distribution supply chain in Europe and Nordics

could be based on the defined optimum, which leaves the defining next steps and how to use the information gathered from the study for Metso. Taking the advantage of what is stated requires decision to change more structural responsibilities within the company to challenge the way of working towards customers. If this is decided as the way to go, the road is going to be long, but luckily includes also easier changes.

The current inbound lanes create unnecessary internal transportation costs and making changes at least from largest suppliers would already provide some easy savings. Outbound set up follows on strict market limitations that should not exist in a company strategies itself to work as one Metso. By removing those and bringing wears inventory closer to customer notable benefits, both in customer service and profitability could be reached. Suggestion is to continue to close warehouses to reduce the number from 9 to 5, but while doing that it is good to start with the first mentioned steps and additionally consider alternative supply chain models like point to point or customer consolidation. However, none of the above solutions will not fully work, unless channels to enter the orders and processes to enabling to carry out what is promised are not aligned and followed.

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